Hazus Flood Model User Guidance

August 2018



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1 Introduction

The Hazus flood loss estimation methodology (Flood Model) provides local, state, and regional officials with a state-of-the-art decision support software for estimating potential losses from flood scenarios. This loss estimation capability will enable users to anticipate the consequences of future floods and to develop plans and strategies for reducing risk. The Geographic Information System (GIS)-based software can be applied to study small or large geographic areas with a wide range of population characteristics.

The Hazus methodology was developed for the Federal Emergency Management Agency (FEMA) by the National Institute of Building Sciences to provide a tool for developing earthquake loss estimates. Hazus has been expanded to perform similar loss evaluations for hurricane wind, flood, and tsunami.

If Hazus is applicable for all regions across the nation with flood risk, loss estimates would help guide the allocation of federal resources to stimulate risk mitigation efforts and plan for federal flood response.

This manual, Hazus Flood Model User Guidance (User Guidance), provides background and instructions on identifying the flood hazard, developing an inventory for a flood loss estimation study, how to use the model, run basic analyses, interpret results, and report model outputs.

The Hazus Flood Model Technical Guidance (Technical Guidance) comprises separate accompanying documents. It provides information on the default data, the origin of each type of inventory, and the methods of calculating losses by changing basic parameterizations.

This User Guidance and the Technical Guidance provide a comprehensive overview of the Flood Model.

1.1 Hazus Users and Applications

Hazus can be useful for a variety of users with a variety of data needs, including:

- A local or state government official may be interested in the costs and benefits of specific mitigation strategies and may want to know the expected losses if mitigation strategies have (or have not) been applied.
- 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 and community planners may want to know the locations and durations 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 and immediately following a flood to best direct resources to the disaster area.

• Insurance companies may be interested in monetary losses so they can assess asset vulnerability.

1.2 Flood Model Outputs

Table 1-1 lists the Flood Model outputs. See Chapter 8 for details on each type of output.

Examples of pre-flood applications of the outputs may include:

- The development of flood hazard mitigation strategies that outline policies and programs for reducing flood losses and disruptions; may involve elevating potential structures or examining areas for potential buyouts
- Anticipation of the nature and scope of response and recovery efforts, including identifying short-term shelter requirements and debris management requirements

Examples of post-event applications of the outputs may 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 economic impact on public and private resources, local governments, and the functionality of the area
- Activation of immediate emergency recovery efforts, including provision of emergency housing shelters and initiating debris clean-up efforts
- Application of long-term reconstruction plans including the identification of long-term reconstruction goals, the institution of appropriate wide-range economic development plans for the entire area, allocation of permanent housing needs, and the application of land use planning principles and practices

Output	Description
Flood Hazard Maps	Flood depth
	Agricultural products
General Building Stock	Damage by occupancy
(GBS)	 Damage by building type
	 Damage by building count
	 Loss from building repair or replacement
	Loss from contents
	 Loss from business inventory
	 Loss from rental income
	 Loss from relocation costs
	 Loss from business income loss
	 Loss from employee wage loss

Table 1-1: Flood Model Outputs

Output	Description
Combined Wind and Flood Loss	 Loss by general occupancy Loss by specific occupancy Loss by general building type
Essential Facilities	 Loss from building repair or replacement Loss from contents
User-Defined Facilities	 Loss from building repair or replacement Loss from contents Loss from business inventory
Transportation Systems	Loss from damage to transportation system components
Utility Systems	Loss from damage to utility system components
Agricultural Products	Loss from damage to crops
Vehicles	Vehicle damage countsLoss from damage to vehicles
Debris	Building debris generated by weight and type of material
Shelter	Number of displaced householdsNumber of people requiring temporary shelter

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

1.3 Assumed User Expertise

Users can be divided into two groups: model users (those who perform the study) and end users (those who use the study results). References to users in this manual include both groups.

The two groups normally consist of different people, but may consist of the same people. The more interaction between these two groups, the better the study. End users should be involved from the beginning of the study to ensure that the results are usable.

The model users who perform the study should have a basic understanding of flood risk and potential consequences.

A loss study will be performed by a representative team consisting of the following:

- Floodplain managers
- Structural engineers or architects
- GIS professionals
- Economists
- Sociologists

- Emergency planners
- Loss estimate users

These individuals are needed to develop flooding scenarios, develop and classify building inventories, provide and interpret economic data, provide information about the local population, and provide input on the types of loss estimates that are needed to fulfill the goals of the study.

If a local or state agency is performing the study, some of the expertise may be in-house. Personnel with relevant expertise are generally in departments such as building permits, public works, planning, public health, engineering, GIS, climatology, information technologies, finance, historic preservation, natural resources, and land records. Although in-house expertise may be readily available, the value of the participation by individuals from academic institutions, citizen organizations, and private industry cannot be underestimated.

1.4 When to Seek Help

The results of a loss estimation study should be interpreted with caution because default input values have a great deal of uncertainty.

If the loss estimation team does not include individuals with expertise in the areas described in Section 1.2, one or more consultants will likely be needed to help interpret the results. It is also advisable to retain objective reviewers with relevant expertise to evaluate the map and tabular data outputs. A floodplain manager, hydrologist, or hydraulic engineer may be needed to provide deterministic or probabilistic scenario data or review the software parameters.

If the user intends to modify the default inventory data or parameters, assistance will be required from an individual with relevant expertise. For example, if the user wishes to change the default percentages of foundation types in a region, a structural engineer with knowledge of regional design and construction practices would be helpful. Modifications to defaults in the economic loss models will require input from an economist.

1.5 Technical Support

As shown in Figure 1-1 and provided in the Hazus application at **Help / Obtaining Technical Support**, technical assistance is available via the Hazus Help Desk at <u>hazus-</u> <u>support@riskmapcds.com</u> or 1-877-FEMA-MAP (1-877-336-2627). The websites for agencies and organizations listed in this document provide Frequently Asked Questions, software updates, training opportunities, and user group activities.

The application's **Help** menu references the help files for ArcGIS. Because Hazus was built as an extension to ArcGIS functionality, knowing how to use the ArcGIS and ArcGIS Help Desk will help Hazus users.

Technical support on any of the four hazards is available at the contacts shown in Figure 1-1 and via **Help** / **Obtaining Technical Support**.

Figure 1-1: Hazus Technical Support

Technical Support
Hazus You may obtain technical assistance for Hazus by calling 1-877-FEMA MAP (1-877-336-2627) or sending an email to: hazus-support@riskmapcds.com.
OK

1.6 Uncertainties in Loss Estimates

Although the software offers users the opportunity to prepare comprehensive loss estimates, even with state-of-the-art techniques, uncertainties are inherent in any estimation methodology. The Flood Model is only a tool for loss estimation from modeled flood events. Hazus does not compute uncertainties in the loss estimates, provide ranges for possible losses, or offer any confidence levels. The output of hard numbers is tied to the input data. Uncertainties may be estimated, but Hazus does not output such statistics.

1.7 Organization of User Guidance

This User Guidance provides information that will assist Flood Model users perform basic and advanced flood loss estimations.

Chapter 1: Introduction. Background on the Flood Model, Hazus applications, assumed user expertise, when to get help, technical support, and uncertainty in loss estimates.

Chapter 2: Overview of the Flood Model. Overview of the Flood Model for local, state, and regional officials contemplating a flood loss study. It describes riverine and coastal flood hazards in the Flood Model; types of buildings, facilities, and lifeline systems in the model; and the difference between a basic and advanced analysis.

Chapter 3: Getting Started I: Hazus Startup Screen. Description of the Hazus Startup screen with information about creating a new Study Region and how to open, delete, duplicate, export, and import existing Study Regions.

Chapter 4: Getting Started II: Basic Hazus Analysis. Introductory walk through of the Flood Model showing a user how to conduct a single-event riverine flood analysis.

Chapters 5, 6, 7, 8, and 9: Model Menus for Inventory, Hazard, Analysis, Results, and Other Items. Walk through of the Flood Model menus related to inventory, hazard, analysis, results, and other menu items.

Chapters 10, 11, and 12: Advanced Hazus Analysis. How to conduct an advanced flood analysis, including information on user-defined inventory data, importing user-defined hazard data, and combined wind and flood hurricane surge analysis.

Chapter 13: Quick Look and Enhanced Quick Look. Step-by-step instructions on how to perform Quick Look and Enhanced Quick Look analyses.

Chapter 14: Acronyms and Abbreviations.

Chapter 15: Glossary. Glossary of key terms.

2 Overview of the Flood Model

Chapter 2 provides an overview of the flood loss estimation methodology (Flood Model) and is intended for local, state, and regional officials contemplating a flood loss study. For more information on flood modeling approaches and assumptions (along with how uncertainties are addressed), consult the Technical Guidance.

The Flood Model will generate an estimate of the consequences to a county or region of a scenario flood (i.e., a flood of a specified magnitude). The loss estimate will describe the scale and extent of damage and the disruption that may result from a potential flood. 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); 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 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 general building stock (GBS), 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 (default data are useable in the calculation of losses)

These systems, methods, and data have been combined in user-friendly GIS software for this loss estimation application. GIS technology facilitates the manipulation of data on GBS, population, and the regional economy.

The software uses GIS technologies for displaying and manipulating inventory and displaying losses and consequences on applicable 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 complexity, 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 accurate the results.

Figure 2-1 shows the conceptual steps that are typically performed in assessing and mitigating the impacts of a natural hazard such as a flood. The methodology incorporates inventory collection and hazard identification into the natural hazards impact assessment.



Figure 2-1: Conceptual Steps in Assessing and Mitigating Losses Due to Natural Hazards

While Figure 2-1 shows the conceptual steps in a natural hazard analysis, the steps used in the Flood Model are as follows:

- Select the area to be studied. The region of interest is created based on census tract, census block, county, state/territory, community, or watershed. 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 hazard. In the Flood Model, the hazard can be specified as riverine, coastal, or a combination of riverine and coastal.
- Provide additional information describing the building inventory, or Essential Facilities, if available.
- Using formulas embedded in Hazus, Hazus computes expected building losses, expected contents losses, and expected loss-of-use for different classes of buildings.
- Hazus uses the above results to compute estimates of direct economic loss and shortterm shelter needs.

The user plays a 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 aggregated by county or region.

2.1 Flood Hazards in the Flood Model

The Hazus Flood Model analyzes both riverine and coastal flood hazards. Flood hazard is defined by a relationship between depth of flooding and the annual chance of inundation to that depth.

Depth, duration, and velocity of water in the floodplain are the primary factors contributing to flood losses. Other hazards associated with flooding that contribute to flood losses include channel erosion and migration, sediment deposition, bridge scour, and the impact of flood-borne

debris. The Hazus Flood Model allows users to estimate flood losses from depth of flooding. The agriculture component will allow the user to estimate a range of losses to account for flood duration. The Flood Model does not estimate the losses due to high-velocity flash floods.

Flood warning is one offsetting component to the primary flood damage factors identified above. The Flood Model allows the user to perform "what-if?" analyses to identify what percentage of losses avoided may make a warning system beneficial. This methodology follows the U.S. Army Corps of Engineers approach using the "Day" curves.

In different contexts, flood hazard may have different meanings. Hazard can mean risk in some contexts and it can mean a source of danger in others. The hazard may be that an area is inundated about once every 10 years (risk) or it may be that an area is subject to flood depths ranging from 5 to 10 feet (source of danger). Flood frequency studies combine these ideas and define flood hazard in terms of the chance that a certain magnitude of flooding is exceeded in any given year.

Flood magnitude is usually measured as a discharge value, flood elevation, or depth. For example, flood magnitude may be referred to as the 100-year flood elevation, which is the elevation, at the point of interest, that has a 1 percent annual chance of being exceeded by floodwater. Using the flood frequency convention, flood hazard is defined by a relation between depth of flooding and the annual chance of inundation greater than that depth. The relation is called a depth-frequency curve.

2.2 Types of Buildings, Facilities, and Lifeline Systems Considered

The buildings, facilities, and systems considered by the methodology are listed below. See the Technical Guidance for more information.

 General Building Stock (GBS) – Most commercial, industrial, and residential buildings are not considered individually when calculating losses. Instead, they are grouped into five general building types and 33 occupancy classes. Degrees of damage and loss are computed for each group.

Examples of general building types include wood, steel, concrete, manufactured housing, and masonry.

Examples of occupancy classes are single-family dwelling, retail trade, heavy industry, and churches.

All structures that are evaluated in this manner are referred to as GBS.

- 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 role
 they often play in housing displaced people. Generally, there are few Essential Facilities
 in a census tract, making it easier to obtain site-specific information for each facility.
 Thus, damage and loss-of-function are evaluated on an individual building basis even
 though the uncertainty in each estimate is large.
- User-Defined Facilities (UDFs) UDFs are buildings at specific locations that are added to the inventory. This site-specific or structure based analysis allows for specific loss and

damage information to be calculated for each individual building, thus improving the accuracy of the results.

 Lifeline Systems – The Flood Model includes analysis for transportation and utility systems. Transportation system components analyzed include bridges for highways and railways, facilities associated with highways, railways, light rail, bus, port, ferry, and airport locations. Utility system components analyzed include portable water, waste water, natural gas, electric power, and communications locations.

2.3 Levels of Analysis

Hazus is designed to support two general types of analysis (Basic and Advanced) split into three levels of data updates (Levels 1, 2, and 3). Figure 2-2 provides a graphic representation of the various levels of analysis.

2.3.1 Basic Analysis

Level 1

A Basic Level 1 analysis is the simplest type of analysis requiring minimum effort by the user. It is based primarily on data provided with the software (e.g., census information, broad regional patterns of foundation distributions, no floodplain code adoption). The user is not expected to have extensive technical knowledge. While the methods require some user-supplied input to run, the type of input required could be gathered by contacting government agencies or by referring to published information. At this level, estimates are generalized and will be appropriate as initial loss estimates to determine where detailed analyses are warranted.

2.3.2 Advanced Analysis

Level 2

An Advanced Level 2 analysis improves Level 1 results by considering additional data that are readily available or can be easily converted or computed to meet methodology requirements. In Level 2, the user may need to determine parameters from published reports or maps as input to the model. It requires more extensive inventory data and effort by the user than a Basic Level 1 Analysis. The purpose of this type of analysis is to provide the user with the best estimates of hazard input data that can be obtained using the standardized methods of analysis included in the methodology. For example, user-supplied flood depth grids should be used over the internal Hazus hydrologic and hydraulics model. Hazus User Manuals provide detailed instructions on how to perform various type of Advanced Level 2 analysis.

Level 3

An Advanced Level 3 analysis requires effort by the user to develop and update information concerning the underlying engineering and loss analysis parameters in Hazus. This type of analysis incorporates results from engineering and economic studies carried out using methods and software not included within the methodology. At this level, one or more technical subject matter experts are required to acquire data, perform detailed analyses, assess damage/loss, and assist the user in gathering extensive inventory data. There are no standardized Advanced Level 3 analysis approaches. Users must understand where, within the Hazus software, to

change the underlying engineering and loss parameters used for an analysis. The quality and detail of the results will depend on the level of effort.

Figure 2-2: Levels of Hazus Analysis



2.4 Analysis Considerations for Flood Model

2.4.1 Analysis Based on Default Information

The basic level of analysis uses the default GBS and Essential Facility databases that are built into the model and extracted for a specific Study Region. These databases are derived from national-level data sources for building square footage, building value, population characteristics, costs of building repair, and economic data. Direct economic and social losses associated with the GBS are computed, along with Essential Facility functionality, short-term shelter requirement, and debris. The uncertainties are large; therefore, the analysis involves only default data sources.

In an analysis based on default data, the user's effort is limited to defining the Study Region, specifying the hazard (probabilistic or deterministic), and deciding the extent and format of the output. However, since default rather than actual data are used to represent local conditions, limitations exist in the estimated levels of damage and losses. An analysis based on default data is suitable primarily for preliminary evaluations and regional comparisons. It is always recommended that users import custom or user-defined flood depth grids when available.

2.4.2 Analysis with User-Supplied Inventory Data

The results from an analysis using only default inventory can be improved greatly by inputting at least a minimum amount of locally developed data. Such an analysis is what is intended. Improved results are highly dependent on the quality and quantity of improved inventories. The significance of the improved results also relies on the user's analysis priorities. The following inventory improvements impact the accuracy of analysis results:

- Use of locally available data or estimates concerning the square footage and counts of buildings in different occupancy classes
- Use of local expertise to modify, primarily by judgment, the databases concerning percentages of foundation 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
- Development of flood 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

3 Getting Started I: Hazus Startup Screen

The Hazus Startup screen is the first screen users will see after launching Hazus.

3.1 Hazus Startup

Before running a loss estimation analysis, users must define a Study Region. The Study Region in Hazus is the geographic unit for which data are aggregated, the flood hazard is defined, and the analysis is carried out. Before starting, make sure that the appropriate state(s)'s Hazus data have been downloaded (<u>http://msc.fema.gov/portal/resources/hazus</u>) and extracted here: C:\HazusData\Inventory.

Hazus will prompt users to create a new region or import a previously created region. Users can also open, delete, duplicate, backup, or export an existing region.

3.2 Create New Region

In the **Hazus Startup** screen (Figure 3-1), users will take the first step in defining the Study Region. In Figure 3-1, **Create a new region** has been selected. Click **OK** to activate the window shown in Figure 3-2.

Click **Next** to open the window shown in Figure 3-3 and name the region in the first box (up to 18 characters, no spaces, and must not begin with a number). Enter a description of the region in the second box. This is especially helpful if multiple users will be accessing this region in the future. Click **Next**, which will open the window shown in Figure 3-4. Select **Flood** from the **Hazard Types** and click **Next**. This selection cannot be altered later.



Figure 3-1: Select Create a New Region in Hazus Startup

Create New Region	×
EARTHQUAKE	Welcome to the Create New Region Wizard
	This wizard will guide you through the steps needed to create a new study region.
WIND -	To continue, click Next.
Foop	
- TSUNAMI	
AM	
	< Back Next > Cancel

Figure 3-2: Select Create New Region in Wizard

Figure 3-3: Create a Study F	Region	Name
------------------------------	--------	------

Create New Region	X
Study Region Name Each study region needs to be identified with a unique name.	
Enter below a name which uniquely identifies your region. The name can be up to 18 characters long.	
Region description (optional): This is an example of a region.	1
< Back	Next > Cancel

Figure 3-4: Select Hazard Type for New Region

Create New Region	— X—
Hazard Type The hazard type controls the type and amount of data that will be aggregated. The hazard type selected affects the analysis options that will be available.	
Your study region can include one or more of the following hazards. Check below the hazard(s) you are interested in.	
Earthquake	
Flood	
Hurricane	
🗖 Tsunami	
Notes: 1. Selection of hazards listed above depends upon the hazard modules installed.	
Once a study region is built with a given hazard(s), it cannot be modified later on, in other words, you cannot add another hazard to it. Alternatively, you may re-create a similar region with different hazard(s).	
3. If you are creating a Near Source only Tsunami region, please also check Earthquake checkbox.	
< Back Next >	Cancel

From the window shown in Figure 3-5, select one of the six aggregation levels. Click **Next** to open the window shown in Figure 3-6. Select the state(s) covered by the Study Region. To select multiple states, hold the Shift key while making selections. Click **Next** to open the window in Figure 3-7. Select the county or counties covered by the Study Region.

Click **Next** to open the **Region Wizard Completion** notification shown in Figure 3-8. Click **Finish**. The status window shown in Figure 3-9 will appear. It may take several minutes for the region to be created. Once the process is finished, click **OK** to acknowledge the Study Region has successfully been created (Figure 3-10). The **Start Menu** will reappear.

Create New Region			8
Aggregation Level The aggregation level defines the procedure by which the study is defin	ed.		
You can define your study region at one of the geographic levels. We ca aggregation level. Please select below the aggregation level you want to	ll this the) use.		
C State			
County			
C Census tract			
C Census block			
C Community (NFIP)			
C Watershed			
	< Back	Next >	Cancel

Figure 3-5: Select Desired Aggregation Level

Create New Region				
State Selection The state selection narrows down the location of the region to be created to specific state(s).				
Please select the state(s) for the study region you want to create. States (1 selected): Nevada (NV) New Hampshire (NH) New Jersey (NJ) New Mexico (NM) New York (NY) North Carolina (NC) North Dakota (ND) Northern Mariana Islands(TS Only) (t Ohio (OH) Oklahoma (OK) Oregon (OR) Pennsylvania (PA) Puerto Rico (PR) Show map				
	< Back Next > Cancel			

Figure 3-6: Select Appropriate State for the New Region

Create New Region County Selection The county selection defin region.	nes the i	county or counties with	in previou	Isly selected state(s), to include in the study
Please select the county States: North Carolina (NC)	or coun	ties for the study regior Counties (1 selected Alamance Alexander Alleghany Anson Ashe Avery Beaufort Bertie Bladen Brunswick Buncombe Purke		t to create. Select all counties Deselect all counties Show map
				< Back Next > Cancel

Figure 3-7: Select County for the New Region



Figure 3-8: Create New Region Wizard Completion

Figure 3-9: Create New Region Progress

Processing Status	
Aggregate Boundaries	
Copy Census Blocks	
	Cancel
Figure 3-10: Create New Region Acknowledgement



3.3 Open Region

The **Open a region** option will not be available in the **Hazus Startup** screen in Figure 3-11 until a region has been created or imported. Select **Open a region** and click **OK**. The **Open Region Wizard** will appear (Figure 3-12). Click **Next**. An **Open Region** list will appear (Figure 3-13). Select which region should be opened. Click **Next**. Verify that the region name and hazard type are correct (Figure 3-14). Click **Finish**. Clicking **Finish** will launch ArcMap. Refer to the additional Hazus User Manuals for guidance.



Figure 3-11: Select Open a Region

Open Region		
EARTHQUAKE • WIND • FLOOD • TSUN	Welcome to the Open Region Wizard This wizard will help you select a study region from among the regions you have already created. To continue, click Next.	
	< Back Next > Cancel	

Figure 3-12: Open Region Wizard

Open Region			
Select Region The study region selection sets the region that will be opened.			
Select the study region you so far.	want to open from the list of study reg	ons you have created	
Region	Description	Created	
Brunswick_NC	Brunswick NC flood	3/19/2018 8:40:	
4		٨	
,			
	< Back	Next > Cancel	

Figure 3-13: Select the Region to Open

Open Region 🧾		
EARTHQUAKE	Completing the Open Region Wizard	
UAK	You have successfully completed the Open Region Wizard.	
	You have selected to open the region:	
	Brunswick_NC	
WIND - FLOO	The hazard you selected was: Flood	
D TSUN	To close this wizard, click Finish.	
	< Back Finish Cancel	

Figure 3-14: Open Region Wizard Completion

3.4 Delete Region

The **Delete a region** option will not be available in the **Hazus Startup** screen in Figure 3-15 until a region has been created or imported. Select **Delete a region** and click **OK**. A **Delete Region** list will appear (Figure 3-16). Select a region from the list and click **Delete** to permanently delete the region. The **Delete Region Confirmation** window will appear (Figure 3-17). Click **Yes** to delete or **No** to return to the **Delete Region** window (Figure 3-16). Click **Done** to close the window and return to the **Hazus Startup** screen.

Hazus Startup	X
	Welcome to Hazus.
FLOOD	In order to use Hazus, you need to define the study region to be used in the analysis.
	Please select the desired option below, and a wizard will guide you through the necessary steps.
	C Create a new region
	C Open a region
	Delete a region
DUAKE	C Duplicate a region
Q Z	C Export/Backup a region
La State	C Import a region
M M	E xit

Figure 3-15: Select Delete a Region

Delete Region			
Below is a list of the study region Right-click mouse for more optic	ns you have created so far. S ons.	Select the region you v	vant to delete.
Region	Description		Created
Brunswick_NC	Brunswick NC flood		3/19/2018 8:40:26
< III			•
, .			
# regions listed: 1		Delete	Done

Figure 3-17: Delete Region Confirmation



3.5 Duplicate Region

The **Duplicate a region** option will not be available in the **Hazus Startup** screen in Figure 3-18 until a region has been created or imported. Select **Duplicate a region** and click **OK**. A **Duplicate Region** list will appear (Figure 3-19). Select the region from the list to be duplicated. Click **Duplicate**. A duplicate region confirmation window will appear (Figure 3-20). Click **Yes** to duplicate or **No** to return to the **Hazus Startup** screen (Figure 3-18). The **Duplicate Region Name** dialog will appear (Figure 3-21). Enter the name of the new region (18 characters and no spaces) and a brief description. Click **OK**. A progress bar will appear (Figure 3-22). It will close once the region has been successfully duplicated. This may take several minutes depending on the size of the region and the speed of the computer. A duplicate region completion notification (Figure 3-23) will appear to notify the user that the region has been duplicated. Click **OK** to return to the **Duplicate Region** list (Figure 3-19). Click **Done** to return to the **Hazus Startup** screen.



Figure 3-18: Select Duplicate a Region

Du	Duplicate Region			
	Below is a list of the study regi and then click 'Duplicate' butto	ons you have created so far. S on below.	Select the region you (
	Region	Description		Created
	Brunswick_NC	Brunswick NC flood		3/19/2018 8:40:26
				•
	Region: Brunswick_NC			
	# regions listed: 1		Duplicate	Done

Figure 3-19: Select a Region to Duplicate

Figure 3-20: Duplicate Region Confirmation



Figure 3-21: Provide Duplicate Region Name

Duplicate Region Name	X
Name duplicated region as:	OK
Duplicate	Cancel
Description (optional):	
Brunswick NC duplicate region	

Figure 3-22: Duplicate Region Progress



Figure 3-23: Duplicate Region Completed



3.6 Export/Backup a Region

The **Export/Backup a region** option will not be available in the **Hazus Startup** screen in Figure 3-24 until a region has been created or imported. Select **Export/Backup a region** and click **OK**. An **Export/Backup Region** list will appear (Figure 3-25). Select the region to export or backup from the list. Click **Browse** to select a file location to save the export/backup. Click **Export/Backup**. A progress bar (Figure 3-26) will appear. It will close once the region has been successfully exported. This may take several minutes depending on the size of the region and the speed of the computer. An **Export/Backup Region Completion** notification (Figure 3-27) will appear once the export has completed. Click **OK**.

Hazus Startup	
	Welcome to Hazus.
FLOOD	In order to use Hazus, you need to define the study region to be used in the analysis.
QUAKE • WIND • F	Please select the desired option below, and a wizard will guide you through the necessary steps.
TSL INI	C Create a new region
3 8	C. Open a region
5	O Delete a region
K L	O Duplicate a region
Q 3	Export/Backup a region
La State	C Import a region
E E	Exit

Figure 3-24: Select Export/Backup a Region

E×	Export/Backup Region			
	Below is a list of the study regions you have created so far. Select the region you want to export/backup, then specify the name of the export file by clicking 'Browse', and finally click 'Export/Backup' button to start the export.			
	Region	Description		Created
	Brunswick_NC	Brunswick NC flood		3/19/2018 8:40:26
	∢ [•
	Region:	Brunswick_NC		
	Export file name:	C:\Exports\Brunswick_NC.hpr		Browse
			Export/Backup	Close

Figure 3-25: Select a Region to Export or Backup

Figure 3-26: Export/Backup Region Progress



Figure 3-27: Export/Backup Region Completed



3.7 Import a Region

Select **Import a region** from the **Hazus Startup** screen in Figure 3-28 and click **OK**. Check the latest Hazus version release notes for limitations on importing from previous versions of Hazus. Hazus is backwards compatible only one version, so only Hazus 4.0 exported regions can be imported into Hazus 4.2 (there was no Hazus 4.1 release). A file explorer will open. Select an export Hazus Packaged Region (.hpr) file. In the **Imported Region Name** dialog (Figure 3-29), enter the name of the region (18 characters and no spaces) and a brief description. The name must be different than the imported .hpr file name. Click **OK**. A progress bar (Figure 3-30) will appear. It will close once the region has been successfully imported. This may take several minutes depending on the size of the region and the speed of the computer. A **Region Import Completion** notification will appear once the export has completed. Click **OK**.

Hazus Startup	
	Welcome to Hazus.
FLOOD	In order to use Hazus, you need to define the study region to be used in the analysis.
·	Please select the desired option below, and a wizard will guide you through the necessary steps.
	C Create a new region
* *	C Open a region
	C Delete a region
MM	C Duplicate a region
Q 3	C Export/Backup a region
Ta Sta	Import a region OK
M M	Exit

Figure 3-28: Select Import a Region

Imported Region Name	— ×-
Name imported region as:	(OK)
Brunswick_Import	Cancel
Description (optional):	
Brunswick NC import example	

Figure 3-29: Provide the Name for the Imported Region

Figure 3-30: Import Region Progress



Figure 3-31: Region Import Completed



4 Getting Started II: Basic Hazus Analysis

The Flood Model allows practitioners to estimate the economic and social losses from flood events. The information provided by the model will help state and local officials evaluate, plan for, and mitigate the effects of flooding. The Flood Model provides practitioners and policy makers with a tool to help reduce flood damage, reduce disaster payments, and make wise use of the nation's emergency management resources.

Chapter 4 explains how to run a basic riverine Flood Level 1 GBS Analysis for a single flood event with flooding modeled by Hazus. This analysis makes use of census blocks that have been dasymetrically-adjusted based on land cover data, meaning that areas with land cover types that typically do not contain structures have been removed from the census block boundaries. Refer to the Flood Technical Manual for information on dasymetric census blocks and the methodology used by Hazus to produce the flood depth raster.

Launch Hazus and select **Open a Region** on the **Hazus Startup** screen (Figure 4-1). Information on the other options is provided in Chapter 3. Click **OK**, which will open the **Welcome to the Open Region Wizard** (Figure 4-2). Select **Next**.



Figure 4-1: Open a Region

Figure 4-2: Open Region Wizard



In the **Select Region** window (Figure 4-3), select the desired Study Region. Click **Next**, which will open the **Completing the Region Review Wizard** (Figure 4-4). Here, the user can review the selected region and hazard. Select **Finish**. An ArcMap window showing the Study Region will open (Figure 4-5).



Open Region			×
Select Region The study region selectic	n sets the region that will b	e opened.	
Select the study region you so far.	want to open from the list o	f study regions you ł	nave created
Region	Description		Created
MontgomeryCo_VA	Basic Hazus Level 1 Rive	erine flood analysi	4/5/2018 12:27:
< <u> </u>			Þ
	< B	ack Next>	Cancel



Figure 4-4: Confirm the Selected Region





To choose a riverine flood hazard type, open the **Hazard** dropdown menu and select **Flood Hazard Type** (Figure 4-6).

Figure 4-6: Select Flood Hazard	Type in Hazard Menu
---------------------------------	---------------------

zard	Analysis	Results	Bookmar	ks
Flo	od Hazard 1	Гуре		
Use	r Data		A	A.
Dev	/elop Strear	n Network	·	-
Sce	nario		•	
Riv	erine		•	
Coa	astal		•	
Qui	ick Analysis		•	
	Flor Use Dev Sce Rive Coa	Flood Hazard T User Data Develop Strear Scenario Riverine Coastal	Flood Hazard Type User Data Develop Stream Network Scenario Riverine	Flood Hazard Type User Data Develop Stream Network Scenario • Riverine • Coastal •

Selecting **Flood Hazard Type** will open the **Flood Hazard Type** window (Figure 4-7). Select **Riverine only**, and click **OK**.

Figure	4-7:	Select	Flood	Hazard	Туре
---------------	------	--------	-------	--------	------

Flood Hazard Type
Study region flood hazard type
Riverine only
🔘 Coastal only
Riverine and coastal
Combined wind and flood
Coastal surge
OK Cancel

To obtain the required digital elevation data required for this analysis, open the **Hazard** dropdown menu and select **User Data** (Figure 4-8). Please note, it is recommended that users import user-defined flood hazard depth grids if available. The Hazus hydrology and hydraulic methodology here should only be used if user-defined data are not available. Please refer to *Hazus Flood Level 2 Standard Operating Procedure* published to the FEMA Library for more information.

Hazard	Analysis	Results	Bookmarks
Flo	od Hazard 1	Гуре	
Us	er Data		AA.
De	velop Strear	n Network	
Sci	enario		•
Riv	/erine		•
Co	astal		•
Qu	ick Analysis		•

Figure 4-8: Select User Data in Hazard Menu

Selecting User Data will open the User Data window (Figure 4-9). Click Determine required DEM extent.

DEM metadata	HEC-RAS		
Vertical units	Meters		•
Vertical datum	NAVD88		•
Other vertical datum			
Select DEM dataset(s)			
Select DEM dataset(s)		*	Browse
			Show
		-	Remove
٠		4	
	Determine required DEM ext	tent	
ogress			
		ОК	Cancel

Figure 4-9: Select Determine Required DEM Extent

After a short pause, the **DEM Extent** window will appear (Figure 4-10). Click **Download and Unzip All** for Hazus to obtain all the required digital elevation model (DEM) files and save them within the Hazus Study Region folder.

	Vestmost L -80.996 v	-	N Nitude	Eastmost Longitude
	t NED Reso ink to dow	olution: 1 Arc-Second -		
	Sno	NED Dataset	Resolution	Last ^ Updated
•	1	USGS NED 1 n38w081 ArcGri	arc-second n38w	2018-02-14
	2	<u>n37w081.zip</u>	1 arc-second	2017-01-27
	3	USGS NED 1 n38w080 ArcGri	arc-second n38w	2018-02-14
	4	<u>n37w080.zip</u>	1 arc-second	2017-01-27
	5	USGS NED 1 n37w082 ArcGri	arc-second n37w	2017-11-15 👻
		ote: Obtaining the DEM data through H	azus requires an inter	net connection.

Figure 4-10: Select Download and Unzip All

Hazus will take several minutes to download and unzip all of the DEM files. When the process has completed, a notification window will appear (Figure 4-11) to indicate the files have been downloaded, unzipped, and saved. Click **OK**.





A popup window (Figure 4-12) will ask the user whether to automatically load the DEM data into the **User Data** window. Click **Yes**.

Figure 4-12: Automatically Load DEM



Hazus will load the file paths for all of the DEM files into the **User Data** window (Figure 4-13). Click **OK** to complete importing the DEM files. Click **Yes** (not shown) on the next popup window to proceed with DEM analysis.

Vertical units	
Vertical datum	Meters
Other vertical datum	
	ut/Flood/DEM/MontgomeryCo_VA/USGS_NED_1 ut/Flood/DEM/MontgomeryCo_VA/USGS_NED_1
•	· · · · · ·
<	Determine required DEM extent

Figure 4-13: Import DEM Files into Hazus

A progress bar (Figure 4-14) will appear as Hazus imports and merges all the individual files into a single DEM for the Study Region. This may take several minutes depending on the size of the Study Region. A notification (Figure 4-15) will appear once the DEM import is completed. Click **OK**.

Figure 4-14: DEM Import Progress



Figure 4-15: DEM Import Completed



The Hazus Flood Model mapping should look similar to Figure 4-16 after the DEM import.



Figure 4-16: Example – Flood Model after DEM Import

To create the stream network, open the **Hazard** dropdown menu and select **Develop Stream Network** (Figure 4-17).



Figure 4-17: Select Develop Stream Network in Hazard Menu

The **Develop Stream Network** window (Figure 4-18) will appear. Use the default value of 10.0 square miles that appears in the drainage area field and click **OK**. Click **Yes** (not shown) on the next popup window to proceed with developing the stream network.

Develop Stream Network	
Input a stream drainage area for When you select OK, the stream created. This process may take	n network will be
Input stream drainage area (affects stream density) (0.25 - 400 square miles)	10.0 Square miles
ОК	Cancel

Figure 4-18: Enter Drainage Area for Develop Stream Network

A progress bar (Figure 4-19) will appear as Hazus performs the GIS analysis to develop the stream network. This may take several minutes to an hour depending on the size of the Study Region. A notification (Figure 4-20) will appear once the stream network has been completed. Click **OK**.

Figure 4-19: Develop Stream Network Progress



Figure 4-20: Develop Stream Network Completed



The Hazus Flood Model mapping should look similar to Figure 4-21 after developing the stream network.



Figure 4-21: Example – Flood Model after Developing Stream Network

To create a scenario within the Flood Model, open the **Hazard** dropdown menu and select **Scenario** and **New** (Figure 4-22).



Figure 4-22: Select Scenario and New in Hazard Menu

The **Create New Scenario** window (Figure 4-23) will appear. Enter a unique name for the scenario and a brief description. Click **OK**.

Create New Scenario	.
Enter a unique name for the Ne	w Scenario:
100-yd	
Description	
	OK Cancel

Figure 4-23: Provide Name for New Scenario

The **New Scenario** window (Figure 4-24) will appear. To select the streams to add to the scenario from the Flood Model mapping, click the **+** button to the right of **Add to selection**. This will activate the screen cursor on the mapping screen in ArcMap, which allows the user to select all the streams in the region.

the scenario. A single scenario may contain more than one object type.	n
	/
Map layer type	
River reaches	
🔘 Coastal shorelines	
🔘 FIT analysis areas	
User-defined depth grids	
Map layer selection	_
Add to selection	5
Remove from selection	
Clear selection	
Save selection	
OK Cancel	

Figure 4-24: Select Add to Selection for River Reaches

Once the streams have been selected, the Flood Model will show the streams in a different color as shown in Figure 4-25.



Figure 4-25: Example – Flood Model after Stream Selection

To complete the stream selection, go back to the **New Scenario** window and click on the button with the disk graphic to the right of **Save selection** (Figure 4-26). The **OK** button will become active. Click **OK** to complete the stream selection.

New Scenario					
Select map features to be included in the scenario. A single scenario may contain more than one object type.					
Map layer type					
River reaches					
Coastal shorelines					
FIT analysis areas					
User-defined depth grids					
Max lauer coloction					
Map layer selection					
Add to selection					
Remove from selection					
Clear selection					
Save selection					
OK Cancel					

Figure 4-26: Select Save Selection to Finalize Selected River Reaches

If the stream selection was performed correctly, the Flood Model should look similar to Figure 4-27. All selected streams are saved to a new data layer called **Chosen Reaches** and are shown in red.



Figure 4-27: Example – Flood Model after Stream Reaches Chosen for a Scenario

To conduct the hydrologic analysis, open the **Hazard** dropdown menu and select **Hydrology** (Figure 4-28).

Hazard Analysis Results E	Bookm	narks	Insert	Selection	Geopro
Flood Hazard Type			- L	Ξ 🇊 👼	in 19
User Data		M		0 🗨 📮	
Develop Stream Network			- AT	dare -	
Scenario	►	and	Gad	P	
Riverine	•		Hydrolo	gy	
Coastal	×		Delineat	te Floodplain	1
Quick Analysis	×		Levee		é
(all	No.		Velocity	,	
10	K		Flow Re	gulation	
and the second se	-sp	1.3	11 1 1 1	ANK	1

Figure 4-28: Select Riverine and Hydrology in Hazard Menu

A notification window (Figure 4-29) will warn the user that raster processing cannot be canceled. Click **Yes**.

A progress bar (Figure 4-30) will appear as Hazus performs the hydrologic analysis. This may take several minutes to several hours depending on the size of the Study Region and the number of selected streams. A notification (Figure 4-31) will appear once the hydrologic analysis has been completed. Click **OK**.



Figure 4-29: Select Yes to Start Hydrologic Analysis

Figure 4-30: Hydrologic Analysis Progress



Figure 4-31: Hydrologic Analysis Completed



If the hydrologic analysis was performed correctly, the Flood Model should look similar to Figure 4-32.



Figure 4-32: Example – Flood Model after Hydrologic Analysis

To conduct the floodplain analysis, open the **Hazard** dropdown menu and select **Delineate Floodplain** (Figure 4-33).



Figure 4-33: Select Riverine and Delineate Floodplain in Hazard Menu

The **Riverine Hydraulic Analysis** window (Figure 4-34) will open. Select **Single Return Period** for **Analysis type**. Keep the default **Output cell size**. Finally, for each stream keep the default return period of 100 years and the default Manning's roughness coefficient n-value shown in the third column of the table. Click **OK**.

Figure 4-34: Delineate Floodplain for a Single Return Period

nalysis type:	Single Return Period	Single Return Period 🔹 👻			
utput cell size:	24.758356682094	•			
River reaches					
Reach ID	Return Period (yrs)	n-value 🦂	<u>^</u>		
6	100	0.160			
15	100	0.160			
16	100	0.160	=		
17	100	0.160	-		
18	100	0.160			
19	100	0.160			
20	100	0.160			
21	100	0.160			
22	100	0.160			
23	100	0.160			
24	100	0.033			
25	100	0.160			
26	100	0.160			
27	100	0.160			
28	100	0.033	T		

A progress bar (Figure 4-35) will appear as Hazus performs the hydraulic analysis needed to delineate the floodplain for each selected stream. This may take several minutes to several hours depending on the size of the Study Region and the number of selected streams. A notification (Figure 4-36) will appear once the floodplain analysis has been completed. Click **OK**.

Figure 4-35: Delineate Floodplain Progress

Processing Status - Reach 1 of 32	
Current progress for reach ID 6 (RP100)	
Calculating bounds and ends	

Figure 4-36: Delineate Floodplain Completed



If the floodplain analysis was performed correctly, the Flood Model should look similar to Figure 4-37.



Figure 4-37: Example – Flood Model after Delineate Floodplain

Begin computing losses within the Study Region's newly delineated floodplains by opening the **Analysis** dropdown menu and selecting **Run** (Figure 4-38).

Analysis Results Bookmarks Insert Damage Functions • • • Restoration Functions • • • Parameters • • • Flood Warning... • • • Average Annualized Loss • • • Quick Analysis... • • •

Figure 4-38: Select Run in Analysis Menu

The Analysis Options window (Figure 4-39) will open. Click the + button to the left of General Building Stock Damage and Loss to expand and view the loss category. Next, click the small open box to the left of General Building Stock Damage and Loss so that all sub categories are also selected. Click OK.

Analysis Options	
Ceneral Building Stock Damage and Loss "	Select All Deselect All
C:\has 96.22 GB free space; [MontgomeryCo_VA] is 268 MB (97.38% free)	OK Cancel

Figure 4-39: Select General Building Stock Damage and Loss from Analysis Options

A progress bar (Figure 4-40) will appear as Hazus calculates flood losses. This may take several minutes to several hours depending on the size of the Study Region. A notification (Figure 4-41) will appear once floodplain losses have been completed. Click **OK**.





Figure 4-41: Flood Losses Completed



At this point, the user will have successfully created a Study Region, delineated streams and floodplains, and calculated losses. For more information on displaying, understanding, and exporting loss results, see Chapter 8.

5 Model Menu: Inventory

The **Inventory** menu, shown in Figure 5-1, has inventory types and subtypes that allow the estimation of the amount of exposure and potential damage in the Study Region. Inventory data include basic information on population, buildings, and facilities obtained from the United States Census and other national sources. These data can be supplemented with additional user supplied datasets. The screenshots in this chapter show all of the options for the **Inventory** menu.

Inve	entory	Hazard	Analysis	Result			
	Gener	al Building	g Stock	•			
	Essential Facilities						
	High Potential Loss Facilities Hazardous Material Facilities						
	User Defined Facilities						
	Transportation Systems						
	Utility Systems						
	Demographics						
	Agricultural Products						
	Vehicles						
	×						

Figure 5-1: Inventory Menu

5.1 General Building Stock

The first type of inventory is **General Building Stock**. The subtypes are Square Footage, Building Count, Valuation Parameters, Dollar Exposure, Depreciation Parameters, Depreciated Exposure, General Occupancy Mapping, Flood Specific Occupancy Mapping, and First Floor Elevations, as shown in Figure 5-2.

Inventory	Hazard	Analysis	Results	Bookmarl	s Insert	Selection	Geoproces	
General Building Stock 🛛 🕨				Square	Footage			
Essential Facilities				Building Count				
High Potential Loss Facilities				Valuati	on Paramet	ters		
Hazardous Material Facilities				Dollar I	Dollar Exposure (Replacement Value)			
User Defined Facilities				Deprec	ation Parai	meters		
Trans	Transportation Systems			Deprec	ated Expos	ure		
Utility	Systems			Genera	Occupano	y Mapping		
Demo	graphics			Flood	pecific Oco	upancy Mag	oping	
	ultural Pro	ducts		First Flo	or Elevatio	ns		

Figure 5-2: Inventory / General Building Stock Menu
5.1.1 Square Footage

Square Footage, opened through the menu shown in Figure 5-2, allows the user to view the type of square footage distribution per the census block, as shown in Figure 5-3.

Square Fo	Jocage					l	
Select Cour	nty to display:						
Brunswick,	. NC (37019) 🛛 👻						
Show Sce	mario Census Blocks						
	CensusBlock	RES1	RES2	RES3A	RES3B	RES3C	RES3D 🔺
1	370190201011000	0.00	0.00	0.00	0.00	0.00	0.0
2	370190201011001	0.00	0.00	0.00	0.00	0.00	0.0
3	370190201011002	0.00	0.00	0.00	0.00	0.00	0.0
4	370190201011003	3.05	10.15	0.00	0.00	0.00	0.0
5	370190201011004	1.52	1.13	0.00	0.00	0.00	0.0
6	370190201011005	3.05	11.28	0.00	0.00	0.00	0.0
7	370190201011006	3.05	6.77	0.00	0.00	0.00	0.0
8	370190201011007	3.05	10.15	0.00	0.00	0.00	0.0
9	370190201011008	0.00	0.00	0.00	0.00	0.00	0.0
10	370190201011009	1.52	5.64	0.00	0.00	0.00	0.0
11	370190201011010	0.00	0.00	0.00	0.00	0.00	0.0
12	370190201011011	3.05	9.02	0.00	0.00	0.00	0.0
13	370190201011012	0.00	0.00	0.00	0.00	0.00	0.0
14	370190201011013	0.00	0.00	0.00	0.00	0.00	0.0
15	370190201011014	4.57	14.66	0.00	0.00	0.00	0.0
16	370190201011015	0.00	0.00	0.00	0.00	0.00	0.0
17	370190201011016	0.00	0.00	0.00	0.00	0.00	0.0
18	370190201011017	1.52	5.64	0.00	0.00	0.00	0.0
19	370190201011018	19.81	59.78	1.89	0.00	0.00	0.0
20	370190201011019	3.05	7.90	0.00	0.00	0.00	0.0 👻
•				1	1		+

Figure 5-3	: Square	Footage	Table
------------	----------	---------	-------

5.1.2 Building Count

Building Count allows the user to review the building count per census block **By Occupancy** and **By Building Type** for specific and general occupancies, as shown in Figure 5-4. The user can view and modify the building count values by only specific occupancy for each census block.

	ilding Cour	nt By Building Type						
1	able Type:							
1	General Occ	upancy Type 🛛 👻	Brunswick, N	IC (37019)	-			
	Show Scena	ario Census Blocks						
		CensusBlock	Total	Residential	Commercial	Industrial	Agriculture	Relig 🔺
	1	370190201011000	0	0	0	0	0	
	2	370190201011001	0	0	0	0	0	
	3	370190201011002	0	0	0	0	0	
	4	370190201011003	12	11	0	0	0	
	5	370190201011004	2	2	0	0	0	
	6	370190201011005	12	12	0	0	0	
	7	370190201011006	8	8	0	0	0	
	8	370190201011007	11	11	0	0	0	
	9	370190201011008	0	0	0	0	0	
	10	370190201011009	6	6	0	0	0	
	11	370190201011010	0	0	0	0	0	
	12	370190201011011	10	10	0	0	0	
	13	370190201011012	0	0	0	0	0	
	14	370190201011013	0	0	0	0	0	
	15	370190201011014	16	16	0	0	0	
	16	370190201011015	0	0	0	0	0	
	17	370190201011016	1	0	0	1	0	
								¥
	∢							•
					Sqft Factors	Close	Map 🗌	Print

Figure 5-4: Building Count (by Occupancy) Table

5.1.3 Valuation Parameters

Valuation Parameters allow the user to review the replacement costs for each occupancy type, as shown in Figure 5-5. Clicking the **Next** button on each window will take the user through the following information windows:

- 1. Replacement Cost (based on a specific year)
- 2. Location Factors
- 3. Single Family (RES1) Garage Distributions by Census Block
- 4. Single Family (RES1) Garage Replacement Cost
- 5. Single Family (RES1) Basement Distribution by Census Block
- 6. Height Distribution (Number of Stories) by Census Block

cement C	ost RES1 Replacer	nent Cost			
placemer	nt Cost				
	 Occupancy 	HazusDefinition	OccupancyExample	MeansCost	
1	RES1	Single Family Dwelling	Refer to hzRES1ReplCost	mediaebox	
2	RES2	Manufactured Housing	Manufactured Housing	41.97	
3	RES3A	Multi Family Dwelling sm		113.69	
4	RES3B	Multi Family Dwelling sm		99.95	
5	RES3C	Multi Family Dwelling ma		179.48	
6	RES3D	Multi Family Dwelling me		168.80	
7	RES3E	Multi Family Dwelling lar		184.58	
8	RES3F	Multi Family Dwelling lar		173.83	
9	RES4	Temp. Lodging	Hotel, medium	189.42	
10	RES5	Institutional Dormitory	Dorm, medium	203.86	
11	RES6	Nursing Home	Nursing home	207.02	
12	COM1	Retail Trade	Dept Store, 1 st	109.60	
13	COM2	Wholesale Trade	Warehouse, medium	106.43	
14	COM3	Personal and Repair Serv		129.25	
15	COM4	Professional/ Technical/		175.24	
16	COM5	Banks	Bank	253.94	
17	COM6	Hospital	Hospital, Medium	335.67	
18	COM7	Medical Office/Clinic	Med. Office, medium	241.31	
19	COM8	Entertainment & Recreati	Restaurant	223.98	
20	COM9	Theaters	Movie Theatre	167.98	
21	COM10	Parking	Parking garage	76.21	
22	IND1	Heavy	Factory, small	130.37	
23	IND2	Light	Warehouse, medium	106.43	
	-				•

Figure 5-5: Valuation Parameters Table

5.1.4 Dollar Exposure (Replacement Value):

Dollar Exposure (Figure 5-6) allows the user to review the exposure per census block **By Occupancy** and **By Building Type**. The user can view and modify the exposure values by only specific occupancy for each census block.

Occupancy	By Building Type					
Table Type	:					
General Oc	ссиралсу Туре 🛛 👻	Brunswick, NC (370	19) 👻	Building	-	
Show Sce	enario Census Blocks					
	CensusBlock	TotalExposure	Residential	Commercial	Industrial	Agriculture
1	370190201011000	0	0	0	0	0
2	370190201011001	0	0	0	0	0
3	370190201011002	0	0	0	0	0
4	370190201011003	1109	728	0	0	0
5	370190201011004	208	208	0	0	0
6	370190201011005	772	772	0	0	0
7	370190201011006	593	593	0	0	0
8	370190201011007	749	728	0	21	0
9	370190201011008	0	0	0	0	0
10	370190201011009	387	387	0	0	0
11	370190201011010	0	0	0	0	0
12	370190201011011	683	683	0	0	0
13	370190201011012	0	0	0	0	0
14	370190201011013	0	0	0	0	0
15	370190201011014	1070	1070	0	0	0
16	370190201011015	0	0	0	0	0
17	370190201011016	76	0	0	76	0
•						-
						r

Figure 5-6: Dollar Exposure Table

5.1.5 Depreciation Parameters

Depreciation Parameters (Figure 5-7) allow the user to review the median year built and median age of buildings in each census block.

	ed Parameters ity to display:			
runswick,	NC (37019) 👻			
		MedianYearBuilt	MedianAge	
1	370190201011000	1994	24	
2	370190201011001	1994	24	
3	370190201011002	1994	24	
4	370190201011003	1994	24	
5	370190201011004	1994	24	
6	370190201011005	1994	24	
7	370190201011006	1994	24	
8	370190201011007	1994	24	
9	370190201011008	1994	24	
10	370190201011009	1994	24	
11	370190201011010	1994	24	
12	370190201011011	1994	24	
13	370190201011012	1994	24	
14	370190201011013	1994	24	
15	370190201011014	1994	24	
16	370190201011015	1994	24	
17	370190201011016	1994	24	
18	370190201011017	1994	24	
19	370190201011018	1994	24	
20	370190201011019	1994	24	
21	370190201011020	1994	24	
	070100001011001	1004	NC 11	•

Figure 5-7: Depreciation Parameters Table

5.1.6 Depreciated Exposure

Depreciated Exposure (Figure 5-8) allows the user to review the depreciated exposure **By Occupancy** or **By Building Type**. This data is calculated based on the median building age and a depreciation curve. The user can view and modify the building depreciated values by only specific occupancy for each census block.

V Occupancy	By Building Type					
Table Type:						
General Oc	cupancy Type 🛛 👻	Brunswick, NC (370	19) 👻	Building	•	
Show Sce	nario Census Blocks					
	CensusBlock	TotalExposure	Residential	Commercial	Industrial	Agriculture
1	370190201011000	0	0	0	0	0
2	370190201011001	0	0	0	0	0
3	370190201011002	0	0	0	0	0
4	370190201011003	714	436	0	0	0
5	370190201011004	151	151	0	0	0
6	370190201011005	497	497	0	0	0
7	370190201011006	398	398	0	0	0
8	370190201011007	501	486	0	15	0
9	370190201011008	0	0	0	0	0
10	370190201011009	231	231	0	0	0
11	370190201011010	0	0	0	0	0
12	370190201011011	411	411	0	0	0
13	370190201011012	0	0	0	0	0
14	370190201011013	0	0	0	0	0
15	370190201011014	697	697	0	0	0
16	370190201011015	0	0	0	0	0
17	370190201011016	55	0	0	55	0
•						-

Figure 5-8: Depreciated Exposure Table

5.1.7 General Occupancy Mapping

The **General Occupancy Mapping** window (Figure 5-9) allows the user to view, copy, edit, and delete the distribution of general building types in the Study Region. By default, the specific state distribution is the only scheme available. This data can be viewed and copied but cannot be edited or deleted. The user can make a copy of the default data (by selecting the default data and clicking **Copy** and entering a new scheme name and description) and edit this data (by clicking the new copy and clicking **Edit**).



Figure 5-9: General Occupancy Mapping Schemes

5.1.8 Flood Specific Occupancy Mapping

Flood Specific Occupancy Mapping (Figure 5-10) allows the user to view the default assumptions for physical building characteristics of structures in any specific occupancy category. There are three default mapping schemes (Coastal, Great Lakes, and Riverine). All three schemes can be copied and the copy versions can be edited to create custom schemes.

For example, to view the Pre- and Post-FIRM (Flood Insurance Rate Map) distributions of foundation types for all RES1 buildings, select a **Mapping Scheme** and click **View**. Figure 5-11 shows the **Flood Building Characteristics Distribution** window that will appear. Users can create custom schemes by clicking the **Copy** button, which activates the **Edit** button. Click **Edit** to change percentage values in the copy.



Figure 5-10: Flood-Specific Occupancy Mapping Schemes

Flood Building Characteristics Distribution					×
Scheme Name: CoastalDflt	Scheme	Description:			
Distribution by:	Pre-Firm	Foundation Types:			
Occupancy RES1 - Single Family Dwelling RES2 - Manufactured Home	1 Pil 2 Pie	er	FoundationDistribution 34 7		2
RES3A Multi Family Dwelling RES3B Multi Family Dwelling RES3C Multi Family Dwelling	4 Ba	ilidWall isement awl	2 0 20		
… RES3D Multi Family Dwelling … RES3E Multi Family Dwelling … RES3F Multi Family Dwelling	6 Fill 7 Sla		0 37		
RES4 Temporary Lodging RES5 Institutional Dormitory RES6 Nursing Home	•				
COM1 Retail Trade COM2 Wholesale Trade COM3 Personal and Repair S		n Foundation Types FoundationType	: AZoneDistribution	VZoneDistribution	
	1 Pil 2 Pie	e	50 15 2	80 15 2	_
COM7 Medical Offices/Clinic COM8 Entertainment & Recre	4 Ba	isement awl	0 20 0	0	
COM9 Theaters COM10 Parking +-	7 Sla		13	2	
Expand All Collapse All					
				ОК	Cancel

Figure 5-11: Flood Building Characteristics Distribution

5.1.9 First Floor Elevations Flood-Specific Occupancy Mapping

The **First Floor Elevations** window (Figure 5-12) allows the user to view the default assumptions for first floor heights of various foundation types. User-defined first floor heights can be assigned by clicking on the **User-defined** tab and selecting the **Use user-defined values** check box. Edit the first floor height values for the foundation types and click **OK**.

fault	User-der	fined			
🔽 Use	e default	values			
	FFEID	Foundation	FirstFloorHeight	Notes	
1	1	Pile	7.00	PRE-FIRM construction in census blocks with	Tr
2	2	Pier	5.00	Riverine construction	
3	3	Solid Wall	7.00	(e.g., HazardType = 1)	
4	4	Basement/Garden	4.00		
5	5	Crawl Space	3.00		1
6	6	Fill	2.00		
7		Slab on Grade	1.00		
8	8	Pile	8.00	POST-FIRM construction in census blocks with	
9	9	Pier	6.00	Riverine construction	
10	10	Solid Wall	8.00	(e.g., HazardType = 1)	
11	11	Basement/Garden	4.00		
12	12	Crawl Space	4.00		
13	13	Fill	2.00		
14	14	Slab on Grade	1.00		
15	15	Pile	7.00	PRE-FIRM construction in census blocks with	
16	16	Pier	5.00	Coastal construction	
17		Solid Wall	7.00	(e.g., HazardType = 2)	
18	18	Basement/Garden	4.00		
19		Crawl Space	3.00		
20	20	Fill	2.00		
21		Slab on Grade	1.00		
22		Pile		POST-FIRM construction in census blocks with	
- 22		n:		Constant and the second s	

Figure 5-12: First Floor Elevations

5.2 Essential Facilities

Selecting **Essential Facilities** from the **Inventory** menu (Figure 5-13) will display the **Essential Facilities Inventory** table (Figure 5-14), which allows the user to view and map the locations and characteristics of medical care facilities, emergency centers, and schools.



Figure 5-13: Inventory / Essential Facilities Menu



💷 Essential Facil	ities Inventory					
Medical Care Fac	cilities Emergency C	enters Schools				
Medical Care						
	ID	Name	Address	City	State	*
1	NC000011	J ARTHUR DOSHER			NC	28461
2	NC000012	BRUNSWICK COMM			NC	28462
						E
				Close	Map	Print

5.3 High Potential Loss Facilities

Selecting **High Potential Loss Facilities** from the **Inventory** menu (Figure 5-15) will display the **High Potential Loss Facilities** table (Figure 5-16), which allows the user to view and map the locations and some characteristics of dams, levees, nuclear power plants, and military installations.



Figure 5-15: Inventory / High Potential Loss Facilities Menu



	al Loss Facilities	,				
)ams & Levees	Nuclear Power Plants	Military Installations				
Nulclear Pow	ver Plants					
	ID	Name	Address	City	ZipCode	-
1	NC000001	Brunswick 1/2		Southport		
						E
•	III					Þ.
				Close	Map	Print

5.4 Hazardous Materials Facilities

Selecting **Hazardous Materials Facilities** from the **Inventory** menu (Figure 5-17) will display the **Hazardous Materials** table (Figure 5-18), which allows the user to view and map the locations and characteristics of hazardous materials sites.



Figure 5-17: Inventory / Hazardous Materials Facilities Menu

Figure 5-18: Hazardous Materials Table

	ID	Name	Address	City	State	Zip
1	NC000014	ADM	"1730 E. MOORE ST	SOUTHPORT	NC	2846106
2	NC000015	ADM	"1730 E. MOORE ST	SOUTHPORT	NC	2846106
3	NC002077	CHEMSERVE TERM	2005 N. 6TH ST.	WILMINGTON	NC	28402
4	NC002123	COATINGS & ADHES	"1901 POPULAR STI	LELAND	NC	2845110
5	NC002124	COATINGS & ADHES	"1901 POPULAR STI	LELAND	NC	2845110
6	NC002125	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
7	NC002126	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
8	NC002127	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
9	NC002128	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
10	NC002129	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
11	NC002130	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
12	NC002131	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
13	NC002132	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
14	NC002133	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
15	NC002134	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
16	NC002135	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
17	NC002136	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
18	NC002137	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
19	NC002138	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
20	NC002139	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
21	NC002140	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
22	NC002141	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
23	NC002142	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
24	NC002143	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
25	NC002144	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
26	NC002145	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
	111					F.

5.5 User-Defined Facilities

Selecting **User-Defined Facilities** from the **Inventory** menu (Figure 5-19) will display the **User-Defined Facilities** table (Figure 5-20), which allows the user to view and map the locations and characteristics of any facilities that have been imported by the user.



Figure 5-19: Inventory / User-Defined Facilities Menu

Figure 5-20: User-Defined Facilities Table

1 US00001 LELAND MIDDLE AN 927 OLD FAYETTEV LELAND NC 28451 2 US00002 LINCOLN POLICE ST 1664 LINCOLN ROA[LELAND NC 28451 3 US00003 BRUNSWICK EOC 114 SCORPION DRIVELAND NC 28451 4 US00004 BRUNSWICK HOSPI 4036 BUSINESS 17 [BOLIVAR NC 28422 5 US00005 SOUTH BRUNSWICI 280 COUGAR DRIVE SOUTH BRUNSWICI NC 28461		ID ID	Name	Address	City	State	Zip
3 US000003 BRUNSWICK EOC 114 SCORPION DRIV LELAND NC 28451 4 US000004 BRUNSWICK HOSPI 4036 BUSINESS 17 (BOLIVAR NC 28422	1	US000001	LELAND MIDDLE AN				
4 US000004 BRUNSWICK HOSPI 4036 BUSINESS 17 BOLIVAR NC 28422	2	US00002	LINCOLN POLICE ST	1664 LINCOLN ROA[LELAND	NC	28451
	3	US000003	BRUNSWICK EOC	114 SCORPION DRIV	LELAND	NC	28451
5 US00005 SOUTH BRUNSWICI 280 COUGAR DRIVE SOUTH BRUNSWICI NC 28461	4	US000004	BRUNSWICK HOSPI	4036 BUSINESS 17 E	BOLIVAR	NC	28422
	5	US000005	SOUTH BRUNSWIC	280 COUGAR DRIVE	SOUTH BRUNSWIC	NC	28461

5.6 Transportation Systems

Selecting **Transportation Systems** from the **Inventory** menu (Figure 5-21) will display the **Transportation Systems Inventory Data** table (Figure 5-22), which allows the user to view and map the location and characteristics of highways, railways light rails, buses, ports, ferries, and airports.



Figure 5-21: Inventory / Transportation Systems Menu



ты	У Railw. le Type:	ay Light Rail Bus	Port Ferry A	irport			
Hig	hway Brid	ges 🔻					
	- 4	ID	Name	Owner	BridgeClass	BridgeType	V -
		NC001448	NC87	State Highway Agenc			
	2	NC001449	SR1455	State Highway Agenc			=
	3	NC001450	US74/76	State Highway Agenc			
	4	NC001451	US74/76	State Highway Agenc			
	5	NC001452	SR1426	State Highway Agenc	HWB28		
	6	NC001453	US421SB/NC133NB	State Highway Agenc	HWB12		
	7	NC001456	NC130	State Highway Agenc	HWB26		
	8	NC001457	SR1521	State Highway Agenc	HWB19		
	9	NC001458	NC87	State Highway Agenc	HWB28		
	10	NC001460	NC904	State Highway Agenc	HWB17		
	11	NC001461	NC133	State Highway Agenc	HWB17		
	12	NC001462	SR1164	State Highway Agenc	HWB17		
	13	NC001463	NC211	State Highway Agenc	HWB28		
	14	NC001465	SR1426	State Highway Agenc	HWB12		
	15	NC001467	US17B	State Highway Agenc	HWB12		
	16	NC001468	NC211	State Highway Agenc	HWB28		
	17	NC001469	NC130	State Highway Agenc	HWB19		
	18	NC001470	SR1112	State Highway Agenc	HWB17		
	10	NC001471	SR1500	State Highway Agend	HWR24		•
	_						- P

5.7 Utility Systems

Selecting **Utility Systems** from the **Inventory** menu (Figure 5-23) will display the **Utility Systems Inventory** table (Figure 5-24), which allows the user to view and map the locations and characteristics of facilities for potable water, waste water, oil, natural gas, electric power, and communications.



Figure 5-23: Inventory / Utility Systems Menu

Figure 5-24: Utility Systems Table

🛯 Utility System	ns Inventory	/						
Potable Water	Waste Wat	er Oil	Natural Gas Electr	ic Power Communic	ations			
Tabl	e Type: P	otable Wa	ter System Facilities			-		
1 401	e type.							
Potable Wat	er							
)	Name	Address	City		State	*
1	NC000013		BALD HEAD ISLAND			NC		28461
2	NC000019		BRUNSWICK CO-BE.		SOUTHPORT	NC		28461
3	NC000020		BRUNSWICK CO-HO	NCSR 1640	NORTHWEST	NC		28422
4	III							E
					Close		Мар	Print

5.8 Demographics

Selecting **Demographics** from the **Inventory** menu (Figure 5-25) will display the **Demographics** table (Figure 5-26), which allows the user to view and map categorical census data aggregated by census block.



Figure 5-25: Inventory / Demographics Menu

Figure 5-26: Demographics Table

	ty to display: NC (37019) -						
runswick,	NC (37019) -						
	CensusBlock	Population	Households	GroupQuarters	MaleLess16	Male16to65	Male(
1	370190201011000	0	0	0	0	0	
2	370190201011001	0	0	0	0	0	
3	370190201011002	0	0	0	0	0	
4	370190201011003	26	10	0	5	6	
5	370190201011004	3	2	0	0	1	
6	370190201011005	41	11	0	5	13	
7	370190201011006	32	8	0	5	8	
8	370190201011007	47	11	0	9	14	
9	370190201011008	0	0	0	0	0	
10	370190201011009	10	5	0	0	4	
11	370190201011010	0	0	0	0	0	
12	370190201011011	41	10	0	8	12	
13	370190201011012	0	0	0	0	0	
14	370190201011013	0	0	0	0	0	
15	370190201011014	45	16	0	6	9	
16	370190201011015	0	0	0	0	0	
17	370190201011016	0	0	0	0	0	
18	370190201011017	18	5	0	3	7	
19	370190201011018	187	55	0	24	55	
20	370190201011019	20	5	0	4	6	
21	370190201011020	347	118	0	58	108	
	070100001011001	444	20	ol	201	24	

5.9 Agricultural Products

Selecting **Agricultural Products** from the **Inventory** menu (Figure 5-27) will display the **Agricultural Products** table (Figure 5-28), which allows the user to view the types and amounts of crops produced in the Study Region.



Figure 5-27: Inventory / Agricultural Products Menu

Figure 5-28: Agricultural Products Table

	Agricultura	al Products				- • ×
s	elect view o	option:				
	County		<, NC (37019) 🗸 🗸			
0	🗇 SubCount		,			
Г		Court Fire	C	C T	A	
	1	CountyFips 37019	CountyName Brunswick	CropType CORN	Average Annual Yield/Acre	06.14 BU
	2	37019	Brunswick	SOYBEANS		39.27 BU
	3	37019	Brunswick	TOBACCO		00.00 LBS
	4	37019	Brunswick	WHEAT		56.67 BU
						E
						-
	•					F.
					Clos	e Print

5.10 Vehicles

Selecting **Vehicles** from the **Inventory** menu (Figure 5-29) will display the **Vehicles** table (Figure 5-30), which shows two tabs with information about vehicle count and dollar exposure by census block. The table can be changed to show daytime or nighttime values using the **Day / Night** dropdown. These values are estimated based primarily on the building occupancies in each census block.







		Day / Night:					
Brunswick, I	NC (37019) 🚽	Daytime		•			
Show Scen	nario Census Blocks						
	CensusBlock	TotalDay	Cars	LightTrucks	HeavyTrucks	Shape	
1	370190201011000	0	0	0	0		
2	370190201011001	0	0	0	0		
3	370190201011002	0	0	0	0		
4	370190201011003	12	7	5	0		
5	370190201011004	0	0	0	0		
6	370190201011005	11	6	5	0		
7	370190201011006	0	0	0	0		
8	370190201011007	1	1	0	0		
9	370190201011008	0	0	0	0		
10	370190201011009	0	0	0	0		
11	370190201011010	0	0	0	0	_	
12	370190201011011	0	0	0	0	_	
13	370190201011012	0	0	0	0	_	
14	370190201011013	0	0	0	0	_	
15	370190201011014	19	11	8	0		
16	370190201011015	1	1	0	0		
17	370190201011016	2	1	1	0	_	
			_	-			

5.11 View Classifications

View Classifications (Figure 5-31) allows users to view definitions of the classification categories. The subtypes are **General Building Stock**, **Essential Facilities**, **High Potential Loss Facilities**, **Transportation Systems**, and **Utility Systems**, as shown in Figure 5-31.

Inventory Hazard Analysis Resu	ts Bookmarks Insert Selection Ge
General Building Stock	i 🔹 🚽 🛃 🗐 🖓 🚳
Essential Facilities High Potential Loss Facilities Hazardous Material Facilities User Defined Facilities	💷 🔛 i 🎢 😤 📯 💿 🗨 🖕
Transportation Systems Utility Systems	
Demographics Agricultural Products Vehicles	
View Classifications	General Building Stock
	Essential Facilities
	High Potential Loss Facilities
	Transportation Systems
	Utility Systems

Figure 5-31: Inventory / View Classifications Menu

5.11.1 General Building Stock Classifications

The **Buildings Classifications** table (Figure 5-32) allows the user to view the assumptions used to define values for **Building Occupancy Classes** and **Model Building Types**.

uilding Type				
	Specific Occupancy	General Occupancy	Description	
1	RES1 RES2	Single Family	Single Family Dwelling	
2		Residential Residential	Manuf, Housing	
3	RES3A	Residential	Duplex	
4	RES3B	Residential Residential	Triplex / Quads	
5	RES3C	Residential Residential	Multi-dwellings (5 to 9	
6	RES3D RES3E	Residential Residential	Multi-dwellings (10 to	
7			Multi-dwellings (20 to	
8	RES3F RES4	Residential Residential	Multi-dwellings (50+ u	
9 10	RES5	Residential	Temporary Lodging Institutional Dormitory	
11	RES6	Residential	Nursing Home	
12	COM1	Commercial	Retail Trade	
12	COM1 COM2	Commercial	Wholesale Trade	
13	COM2 COM3	Commercial	Personal and Repair 9	
14	COM3 COM4	Commercial	Professional/Technic	
16	COM4 COM5	Commercial	Banks	
17	COM6	Commercial	Hospital	
18	COM7	Commercial	Medical Office/Clinic	
19	COM8	Commercial	Entertainment & Recru	
20	СОМ9	Commercial	Theaters	
21	COM10	Commercial	Parking	
22	IND1	Industrial	Heavy	
23	IND2	Industrial	Light	

Figure 5-32: Buildings Classifications Table

5.11.2 Essential Facilities Classification

The **Essential Facilities Classifications** table (Figure 5-33) allows the user to view the assumptions used to define values for **Medical Care Facilities**, **Emergency Centers**, and **Schools**.

🛯 Essential Faci	ilities Classification				- • •
Medical Care Fa	acilities Emergency	Centers Schools			
Medical Care					
	EfClass	Category	Description		
1	EFHL	Medical Care	Large Hospital (greate		
2	EFHM	Medical Care	Medium Hospital (50 t		
3	EFHS	Medical Care	Small Hospital (less th		
4	EFMC	Medical Care	Medical Clinics and L		
5	MDFLT	DEFAULT	Default for Medical		
					E
٠					
				Close	Print

Figure 5-33: Essential Facilities Classification Table

5.11.3 High Potential Loss Facilities Classification

The **High Potential Loss Facilities Classification** table (Figure 5-34) allows the user to view the assumptions used to define values for **Dams & Levees**, **Nuclear Power Plants**, **Military Installations**, and **Hazardous Materials**.

II High Potential Loss Facilities	
Dams & Levees Nuclear Power Plants Military Installations Hazardous Materials	
Nulclear Power Plants	
HplfClass Category Description	
1 HPNP Nuke Nuclear Power Faciliti	
	E
	•
III	•
	lose Print

Figure 5-34: High Potential Loss Facilities Classification (Nuclear Power Plants) Table

5.11.4 Transportation Systems Classification

The **Transportation Systems Classification** table (Figure 5-35) allows the user to view the assumptions used to define values for **Highway**, **Railway**, **Light Rail**, **Bus**, **Port**, **Ferry**, and **Airport**.

ghway Rai	ilway Light Rail Bus	Port Ferry	Airport	
Table Type				
Highway B	ridges 🗾 👻			
	BridgeClass	Calaaan	Description	
1	HDFLT	Category Highway	Default Bridge	
2	HWB1	Highway	Major Bridge - Length	
3	HWB10	Highway	Continuous Concrete.	
4	HWB11	Highway	Continuous Concrete,	
5	HWB12	Highway	Steel, Multi-Column Br	
6	HWB13	Highway	Steel, Multi-Column Br	
7	HWB14	Highway	Steel, Multi-Column Br	
8	HWB15	Highway	Continuous Steel (Cor	
9	HWB16	Highway	Continuous Steel (Sei	
10	HWB17	Highway	PS Concrete Multi-Co	
11	HWB18	Highway	PS Concrete, Multi-Co	
12	HWB19	Highway	PS Concrete, Multi-Co	
13	HWB2	Highway	Major Bridge - Length	
14	HWB20	Highway	PS Concrete, Single (
15	HWB21	Highway	PS Concrete, Single (
16	HWB22	Highway	Continuous Concrete,	
17	HWB23	Highway	Continuous Concrete,	
18	HWB24	Highway	Same definition as HV	
10	HWR25	Hidhwau	Same definition as HV	
•				4

Figure 5-35: Transportation Systems Classification Table

5.11.5 Utility Classifications

The **Utility Classifications** table (Figure 5-36) allows the user to view the assumptions used to define values for **Potable Water**, **Waste Water**, **Oil**, **Natural Gas**, **Electric Power**, and **Communications**.

Tab Potable Wa	ic Type.	ter System Facilities		•
	UtilFcltyClass	Category	Description	
1	PCVS	Control Vaults	Potable Water Contro	
2	PDFLT	DEFAULT	Default Facility	
3	PPPL	Potable Water	Large Pumping Plant	
4	PPPM	Potable Water	Medium Pumping Plar	
5	PPPS	Potable Water	Small Pumping Plant (
6	PSTAS	Potable Water	Above Ground Steel	
7	PSTBC	Potable Water	Buried Concrete Tank	
8	PSTGC	Potable Water	On Ground Concrete	
9	PSTGS	Potable Water	On Ground Steel Tan	E
10	PSTGW	Potable Water	On Ground Wood Tai	
11	PWE	Potable Water	Wells	
12	PWTL	Potable Water	Large WTP (> 200 M	
13	PWTM	Potable Water	Medium WTP (50-20	
14	PWTS	Potable Water	Small WTP (< 50 MG	

Figure 5-36: Utility Classifications Table

6 Model Menu: Hazard

The **Hazard** menu (Figure 6-1) within Hazus has a number of analysis types from which to choose. These options enable the user to select the appropriate analysis to perform on the Study Region. This section explains the selections and the inputs required for each.

Haz	ard Analysis	Results	Bookma		
	Flood Hazard Type				
	User Data				
	Develop Stream Network				
	Scenario 🕨				
	Riverine •				
	Coastal		•		
	Quick Analysis		•		

Figure 6-1: Hazard Menu

6.1 Flood Hazard Type

The riverine and coastal hazards have different requirements for developing the hazard and the digital elevation data required to support the analysis.

The first option on the **Hazard** menu (Figure 6-2) is **Flood Hazard Type**. Selecting this option activates the **Flood Hazard Type** dialog shown in Figure 6-3. In this dialog, the user selects the Study Region's flood hazard type for analysis. The **Coastal surge** option is only enabled if the user is conducting a combined Hurricane and Flood hazard analysis and previously ran the Hurricane model.

The **Flood Hazard Type** selection on the **Hazard** menu (Figure 6-2) prevents users from having to supply unnecessary digital terrain data for the selected hazard type and enables only those menu items that are needed to support the hazard.

Hazard	Analysis	Results	Bookmar	ks
Flo	ood Hazard ⁻	Туре		
Us	er Data		¢	ŝ.
Develop Stream Network				
Scenario 🕨				
Riverine •				
Coastal 🔸				
Quick Analysis				

Figure 6-2: Select Flood Hazard Type

Figure 6-3: Flood Hazard Type Dialog



Users should think carefully about which hazard type (or both) they are interested in analyzing, as the selection will drive the entire hazard assessment. Changing the **Flood Hazard Type** selection will change the DEM requirements and prevent the user from accessing some of the menu items not applicable for that flood hazard type. For example, selection of the **Riverine only** button will require a DEM that covers both the Study Region and all the watersheds that intersect that Study Region and will require the user to develop a stream network, creating a Scenario (described later in this chapter). A coastal analysis does not require a stream network or hydrologic analysis, but does require a DEM for the coastal area of the Study Region.

6.2 User Data

The **User Data** selection from the **Hazard** menu (Figure 6-4) activates the window shown in Figure 6-5. Here, the user can select the appropriate tab to import the relevant data for the analysis. The **User Data** window offers four data import options: **DEM**, **FIT**, **Depth Grid**, and **HEC-RAS**. This chapter will provided details on using the DEM import option, while Chapter 12 provides more details on the other three options.



Figure 6-5: User Data Options Window

Vertical units Vertical datum	Meters NAVD88
Other vertical datu	m
Select DEM dataset(s)	
4	Browse. Show Remove
(Determine required DEM extent
955	ОК Сал

Click **Determine required DEM extent** shown in Figure 6-5 to have the Flood Model determine the DEM files required for the analysis. The extent will be different for riverine versus coastal flood analysis.

After a short pause, the **DEM Extent** window will appear, as shown in Figure 6-6. This window lists the required latitude and longitude coordinates that are needed to download the U.S. Geological Survey (USGS) DEM data. The latitude and longitude shown may extend beyond the defined boundaries of the Study Region because the watersheds that affect the region's flood risk probably extend outside the political boundaries.

Note that any DEM imported into the Flood Model must meet the bounding coordinate constraints established by this dialog. The Model will discontinue processing if it identifies gaps in the data coverage.

Y	′our ana	lusis will require a DEM bounded by t				
	Your analysis will require a DEM bounded by these coordinates in decimal degrees					
Westmost Longitude 37.518 N Eastmost Longitude -80.996 W Southmost Latitude -79.882 W 36.867 N N N N						
	Celect NED Resolution: 1 Arc-Second					
	Sno	NED Dataset	Resolution	Last ^		
•		USGS NED 1 n38w081 ArcGri	arc-second n38w	2018-02-14		
	2	n37w081.zip 1 arc-second 2017-01-27				
	3	USGS NED 1 n38w080 ArcGri	arc-second n38w	2018-02-14		
	4	<u>n37w080.zip</u>	1 arc-second	2017-01-27		
	5	USGS NED 1 n37w082 ArcGri	arc-second n37w	2017-11-15 👻		
Foram	Please note: Obtaining the DEM data through Hazus requires an internet connection. For a manual workaround, please visit http://msc.fema.gov/ned/ or contact the Hazus Help Desk at 1-877-336-2627.					

Figure 6-6: DEM Extent Window

Use the **Select NED Resolution** dropdown menu to choose the desired resolution. The default is 1 Arc-Second (30 meters). Not all Study Regions will have available USGS DEM data for resolutions other than 1 Arc-Second. For example, choosing Alaska 2 Arc-Second for a Study Region in Montgomery County, VA will refresh the table and warn the user "No record found!"

6.2.1 Automated DEM Download

Click **Download and Unzip All** in the **DEM Extent** window shown in Figure 6-6 for Hazus to obtain all the required DEM files and save them within the Hazus Study Region folder.

Hazus will take several minutes to download and unzip all of the DEM files. When the process has completed, a notification window will appear (Figure 6-7) to indicate the files have been downloaded, unzipped, and saved. Click **OK**.

Figure 6-7: DEM Downloaded, Unzipped, and Saved



A popup window (Figure 6-8) will ask the user whether to automatically load the DEM data into the **User Data** window. Click **Yes**.

Figure 6-8: Automatically Load DEM



Hazus will load the file paths for all of the DEM files into the User Data window (Figure 6-9).

M FIT Depth Gr DEM metadata	Id HEC-RAS			
Vertical units	Meters			
Vertical datum	NAVD88			
Other vertical datum				
	Input/Flood/DEM/MontgomeryCo_VA/USGS_NED_1 Show			
C:\HazusData\Hazard C:\HazusData\Hazard	Input/Flood/DEM/MontgomeryCo_VA/USGS_NED_1 Input/Flood/DEM/MontgomeryCo_VA/N37w080/grdr Input/Flood/DEM/MontgomeryCo_VA/USGS_NED_1 Input/Flood/DEM/MontgomeryCo_VA/USGS_NED_1 III			
C:\HazusData\Hazard C:\HazusData\Hazard C:\HazusData\Hazard	Input/Flood/DEM/MontgomeryCo_VA/n37w080/grdr Input/Flood/DEM/MontgomeryCo_VA/USGS_NED_1 Input/Flood/DEM/MontgomeryCo_VA/USGS_NED_1			

Figure 6-9: Import DEM Files into Hazus

Click **OK** to complete importing the DEM files. Click **Yes** (not shown) on the next popup window to proceed with DEM analysis.

A progress bar (Figure 6-10) will appear as Hazus imports and merges all the individual files into a single DEM for the Study Region. This may take several minutes depending on the size of the Study Region. A notification (Figure 6-11) will appear once the DEM import is completed. Click **OK**.

Processing Status	×
Creating study region DEM	
Processing input	

Figure 6-10: DEM Import Progress

Figure 6-11: DEM Import Completed



6.2.2 Manual DEM Download

An alternative way to download DEM data is to manually download each DEM file through the **NED Dataset** link (in blue) in the **DEM Extent** window as shown on Figure 6-12. Click on the link for each file and proceed to download the DEM data. The data will be stored in the form of a zip file, which must be unzipped. Any WinZip compatible program (WinZip, WinRar, 7-Zip, etc.) should be able to unzip the data. For large areas, users will be given the DEM in multiple zip files.

Also note the following:

- If pop-up blockers are enabled on the computer, they should be disabled before the DEM is downloaded.
- The DEM data from the USGS is in meters.
- When unzipping multiple zip files, unzip each file to a new folder location. Each ArcGIS grid has some identical file names that will be over-written if the files are unzipped into only one folder.

V	Vestmost L	.ongitude 37.51		Eastmost Longitude
-80.996 vV Southmost Latitude -79.882 v 36.867 N				
	t NED Resi ink to dow	olution: 1 Arc-Second		
	Sno	NED Dataset	Resolution	Last Updated
Þ	1	USGS NED 1 n38w081 ArcGri	arc-second n38w	2018-02-14
	2	n37w081.zip	1 arc-second	2017-01-27
	3	USGS_NED_1_n38w080_ArcGri	arc-second n38w	2018-02-14
	4	<u>n37w080.zip</u>	1 arc-second	2017-01-27
	5	USGS_NED_1_n37w082_ArcGri	arc-second n37w	2017-11-15
_		ote: Obtaining the DEM data through H		
For a		orkaround, please visit http://msc.fer at 1-877-336-		

Figure 6-12: Manual DEM Download

Once all DEM files have been downloaded and unzipped, click **Close** on the **DEM Extent** window to return to the **User Data** window. Click **Browse** (Figure 6-13) and navigate to each downloaded ArcGIS grid directory (Figure 6-14). Highlight the filename and click **Select** as shown in Figure 6-15. Repeat this process until all grids have been added to the **User Data** window (Figure 6-16).

User Data						
DEM FIT Depth Grid HE	DEM FIT Depth Grid HEC-RAS					
DEM metadata	DEM metadata					
Vertical units	Meters					
Vertical datum	NAVD88					
Other vertical datum						
Select DEM dataset(s)						
Browse						
	Remove					
•	4					
	Determine required DEM extent					
Completed calculating DEM coordinates 36.8670033962474, - 30.9960837101975, 37.5176835435565, -79.8816768321474 OK Cancel						

Figure 6-13: Manually Select DEM File

Figure 6-14: Navigate to Directory with Unzipped DEM Files

Choose a DEM
Look in: 🛅 MontgomeryCo_VA 🔷 🏠 🗔 🏢 🔻 🖆 🍯 🚳
Cn 37w080
C n37w081 USGS_NED_1_n37w082_ArcGrid
USGS_NED_1_n38w080_ArcGrid
USGS_NED_1_n38w081_ArcGrid USGS_NED_1_n38w082_ArcGrid
Name: Select
Show of type: Raster datasets Cancel

Choose a DEM	
Look in: 🛅 r	n37w080 🔹 🛧 🏠 🗔 🏥 🗸 😂 🗊 🚳
grdn37w080	1 La thumb.jpg
Name:	grdn37w080_1 Select
Show of type:	Raster datasets Cancel

Figure 6-15: Select DEM File

Figure 6-16: Import DEM Files into Hazus

DEM FIT Depth	Grid HEC-RAS					
DEWINIetadata	Dew metadata					
Vertical units	Meters					
Vertical datum	NAVD88					
Other vertical o	Other vertical datum					
Select DEM dataset(Select DEM dataset(s)					
C:\HazusData\Haza C:\HazusData\Haza C:\HazusData\Haza C:\HazusData\Haza C:\HazusData\Haza	C:\HazusData\HazardInput\Flood\DEM\MontgomeryCo_VA\USGS_NED_1 C:\HazusData\HazardInput\Flood\DEM\MontgomeryCo_VA\DSGS_NED_1 C:\HazusData\HazardInput\Flood\DEM\MontgomeryCo_VA\USGS_NED_1 C:\HazusData\HazardInput\Flood\DEM\MontgomeryCo_VA\DSGS_NED_1 C:\HazusData\HazardInput\Flood\DEM\MontgomeryCo_VA\USGS_NED_1 C:\HazusData\HazardInput\Flood\DEM\MontgomeryCo_VA\USGS_NED_1 C:\HazusData\HazardInput\Flood\DEM\MontgomeryCo_VA\USGS_NED_1 C:\HazusData\HazardInput\Flood\DEM\MontgomeryCo_VA\USGS_NED_1					
•						
	Determine required DEM extent					
	oleted calculating DEM coordinates 36.8670033962474, - 360837101975, 37.5176835435565, -79.8816768321474 OK Cancel					

Click **OK** to complete importing the DEM files. Click **Yes** (not shown) on the next popup window to proceed with DEM analysis.

A progress bar (Figure 6-17) will appear as Hazus imports and merges all the individual files into a single DEM for the Study Region. This may take several minutes depending on the size of the Study Region. A notification (Figure 6-18) will appear once the DEM import is completed. Click **OK**.

Processing Status Creating study region DEM Processing input

Figure 6-17: DEM Import Progress

Figure 6-18: DEM Import Completed



6.3 Develop Stream Network

If the Study Region is subject to riverine flood hazard, the next step is to generate a stream network. This is not required if the user is only running scenarios with the recommended usersupplied flood hazard data (Flood Information Tool [FIT], depth grids, floating-point binary [.FLT] grids). Generating a stream network is a one-time analysis that establishes the river network identity for all subsequent scenarios.

The **Develop Stream Network** selection on the **Hazus** menu (Figure 6-19) activates the **Develop Stream Network** dialog shown in Figure 6-20. Enter the number of square miles that define the stream drainage area for the Study Region.



Figure 6-19: Select Develop Stream Network

Figure 6-20: Develop Stream Network Dialog

Develop Stream Network				
Input a stream drainage area for the study region. When you select OK, the stream network will be created. This process may take some time.				
Input stream drainage area (affects stream density) (0.25 - 400 square miles)				
ОК	Cancel			

The model will process the DEM for the Study Region to determine the locations of streams. This analysis will take some time, ranging from 5 minutes to several hours, depending on the computer's processing speed, the size of the Study Region, and the complexity of the DEM. When the process is complete, the identified streams will appear on the Study Region, similar to Figure 6-21.

 Selecting a small number of square miles, such as 1, for the drainage area will result in a highly defined stream network. This value represents the total land area, in square miles, that drains into any given reach, excluding that drainage at the starting node of the reach (the downstream node from the prior reach). The smaller the drainage area, the more processing time required by the Flood Model for subsequent analyses.


Figure 6-21: Example – Flood Model after Developing Stream Network

Running the stream network the first time is fairly time consuming as the model performs an analysis to fill in spurious sinks in the DEM. However, to save the user time for subsequent runs, the model saves the results of the sink-filling process. As such, if the user decides to change the drainage area number, the model will not require nearly as much time to perform the analysis. For example, if the user runs the stream network at 5 square miles and then decides that the network requires more detail, changing the drainage area to 1 square mile will process significantly faster than the original analysis. Please note that Hazus must still re-calculate and assign the Manning's-n coefficient, associated with stream roughness, to each reach. This process will appear to the user as "Finalizing Stream Network" and will take additional processing time if the user changes the drainage area value.

If a river in the analysis forms a border between two counties, including both counties on either sides of the river in the Study Region is recommended. The stream network in Hazus is known as a synthetic network because it is derived entirely from the DEM. No imagery or pre-existing map layers are used in its generation. More specifically, streams in a synthetic network exist at DEM grid cell locations that receive drainage from a threshold number of upstream grid cells. If the DEM is not large enough, the threshold number of grid cells may not be reached.

Figure 6-22 shows an example of this situation with a discontinuous synthetic stream. The Study Region consists of one county, for which the one river (displayed in red) forms a border. Because the DEM does not include areas draining to both sides of the river, the resulting

synthetic stream is discontinuous. There are simply not enough DEM grid cells draining to the discontinuous portions to properly delineate them.





The solution to this discontinuity problem is to include counties on both sides of the river during Study Region creation. Including both counties will result in a larger DEM that drains to both sides of the river. Figure 6-23 illustrates this concept using the same stream as shown in Figure 6-22. The second Study Region consists of counties on either side of the river (shown in red) and the resulting synthetic stream network is now continuous.



Figure 6-23: Example Continuous Synthetic Stream

6.4 Scenario

A scenario defines the specific stream reaches, or lengths of coastline for coastal users, and the hydrologic and hydraulic characteristics to be included in one analysis run. A scenario could include all stream reaches in the Study Region, and/or the coastline in a coastal Study Region. However, because the analysis requires significant computer processing, dividing the region into several smaller scenarios may be preferable. Figure 6-24 shows the **Hazard / Scenario** menu with only the **New** selection active prior to defining the first scenario for a Study Region. Figure 6-25 shows the **Hazard / Scenario** menu with all selections active after the initial scenario has been defined.

Hazard Analysis	Results	Bookm	arks	Insert	Selecti
Flood Hazard Ty	/pe			• 🗹	🖽 🧊
User Data			<i>(</i> %)	xt av	
Develop Stream	Network			- 1 AT -	~
Scenario		×		New	
Riverine		•		Open	
Coastal		•		Save As	
Quick Analysis		•		Edit	
				Close	
				Delete	

Figure 6-24: Select New Scenario (Prior to Defining First Scenario)

6.4.1 New

Under the **Scenario** menu option, select **New**, as shown in Figure 6-25, to create a new scenario. The process of defining a new scenario for riverine, coastal, and combined analyses each require different steps. These steps are detailed in the next sections.

Figure 6-25: Select New Scenario (After Defining First Scenario)



6.4.1.1 Riverine Scenario

The **Create New Scenario** window, shown in Figure 6-26, will appear. Enter a name for the scenario and an optional description. Be careful not to include any leading or trailing spaces. The **Description** will be visible to the user when opening scenarios in the future to help differentiate between similarly named scenarios.

Create New Scenario		٢
Enter a unique name for the New	v Scenario:	
MyRiverineCase		
Description		
Riverine scenario for Montgome	κy, VA.	
		1
	OK Cancel	ļ

Figure 6-26: Enter a Name for the New Scenario

After naming the scenario, the **New Scenario** window (Figure 6-27) will open, allowing the user to select which stream reaches to include in the scenario. Click the radio button next to the appropriate **Map layer type**. To select features, click the **Add to selection** (+) button, then drag the selection box around the features to be selected to add reaches to the scenario and then click **Save selection** (the floppy disk icon). The **Remove from selection** (-) button removes reaches from the selected reaches. Similarly, the **Clear selection** (\times) button clears all reaches from the selection.

The selected features will be highlighted in a light blue color, as shown in Figure 6-28. After saving the selected stream reaches, click **OK** to complete the definition of the scenario. The color of the selected reaches changes from light blue to red when this process is complete.

New Scenario		
Select map features to be included in the scenario. A single scenario may contain more than one object type.		
Map layer type		
River reaches		
Coastal shorelines		
 FIT analysis areas 		
 User-defined depth grids 		
Map layer selection		
Add to selection +		
Remove from selection -		
Clear selection		
Save selection		
OK Cancel		

Figure 6-27: Select Map Features

Figure 6-28: Select River Reaches for a Scenario



After selecting the features in the map layer, users must click Save selection for each specific map layer type. For example, if a user wants to create a scenario with river reaches, coastal shorelines, and FIT analysis areas, the user must: 1. Select the River reaches radio button, click the Add to selection button, select reach(es), click the Save selection button. 2. Select the Coastal shorelines radio button, click the Add to selection button, click the Add to selection button. 3. Select the FIT analysis areas radio button, click the Add to selection button, select FIT area(s), click the Save selection button. Click the Add to selection button, select FIT area(s), click the Save selection button. Click OK.

If the user has imported any FIT data and/or flood depth grid(s), those areas can be selected by clicking on the **FIT analysis areas** and/or the **User-defined depth grids** radio buttons. Select and save FIT areas and/or flood depth grids in the same manner as the reach selection.

If more than one flood depth grid is selected for the scenario, the dialog will expand to show the list of selected flood depth grids selections, as shown in Figure 6-29. Users can select one or more depth grids for the scenario.

New Scenario		
Select map features to be included in the scenario. A single scenario may contain more than one object type.	The current selection of depth gric features that may share a commo polygon(s) to include in this scena	n area. Please select the desired
Map layer type		
	Name	Return Period
 River reaches 	1 DG00_montva_1	100 0
Coastal shorelines	2 DG01_montva_5	50 1
 FIT analysis areas 		
 User-defined depth grids 		
Map layer selection Add to selection Remove from selection		E
Clear selection	< III	
Save selection		
OK Cancel	Select All	Select

Figure 6-29: Select User-Defined Depth Grids for a Scenario

6.4.1.2 Coastal Scenario

Coastal analysis does not require the user to generate a stream network or run the hydrologic analysis. However, the user will still be required to obtain and identify the DEM to be used in the analysis. The extent of the DEM necessary for the coastal flood hazard is different from that required for the riverine flood hazard. The necessary DEM is determined by the union of the region shoreline with the Study Region boundary.

Once the DEM has been added, the user can move directly to defining a scenario by selecting **New** from the **Hazard / Scenario** menu. The **Create New Scenario** window will appear (Figure 6-30). As with the riverine analysis, enter a name and, if desired, a description for the scenario, and click **OK**. The window shown in Figure 6-31 will appear.

Create New Scenario	×
Enter a unique name for the New Scenario:	
Scenario1	
Description	_
User Manual Example (BeaufortSC)	
Ι	
OK Cance	el

Figure 6-30: Enter a New Scenario (Coastal)



Figure 6-31: Select a Shoreline for a New Coastal Scenario

Similar to the riverine hazard, the user will be asked to select a shoreline or shorelines for analysis (Figure 6-31). Click the radio button next to the appropriate **Map layer type** (Figure 6-32). The Flood Model uses a standard GIS selection tool to allow the user to select the shorelines. Click the **Add to selection** (+) button, then either click on the shoreline or draw a box to select more than one shoreline.

Select map features to be i the scenario. A single sce contain more than one obje	nario may
Map layer type	
River reaches	
Coastal shorelines	:
🔘 FIT analysis areas	
User-defined dept	h grids
Map layer selection	
Add to selection	•
Remove from selection	-
Clear selection	X
Save selection	
ОК С	ancel

Figure 6-32: Select Shoreline

- To select discontinuous shorelines, such as islands, press the **Shift** key while selecting additional shorelines. To deselect shorelines, press the **Shift** key and click on the shorelines that are not to be included in the selected shorelines.
- Hazus has a built-in default national shoreline that is delineated by county. In Study Regions that are sub-county or a combination of multiple sub-counties, all of the associated shorelines of the counties will be brought in. This is by design to account for coastal flooding at specific locations that does not necessarily originate from the closest shorelines to those locations.
- The Flood Model has shorelines for mainland areas, barrier islands, large islands, small islands, and the Great Lakes. These shorelines have been smoothed to allow the Flood Model to build shore normal transects in a less time-consuming fashion.

Once the shorelines have been selected, click the **Save Selection** button (the floppy disk icon); the **OK** button will become enabled (Figure 6-32). Click **OK**. This completes the process of creating the new scenario and selecting shorelines. The next step in the process is to characterize the chosen shorelines.

The **Shoreline Limits** dialog (Figure 6-33) will automatically pop up after shorelines are selected for the scenario to characterize the limits of the shoreline. This dialog begins the process in which the user identifies where they wish to start characterizing the shoreline (**Shoreline Start**) and where they would like to finish the characterization (**Shoreline End**) as shown on the interactive map layer (Figure 6-34). In between these two points, the user will want to add any breaks in the shoreline (**Breaklines**) where the geographic characteristics of

the shoreline change. The Flood Model will develop transects at 1,000-foot increments and perform the analysis (e.g., simplified Wave Height Analysis for Flood Insurance Studies [WHAFIS]) only between the **Shoreline Start** and **Shoreline End** lines. If the default locations (at the end of each segment) are moved, the Flood Model will limit the development of transects between these locations.

• The Flood Model will develop transects and perform a simplified WHAFIS and runup analysis between the **Shoreline Start** and **Shoreline End** lines—either the default locations or those generated by the user. The Flood Model will still develop a stillwater elevation (SWEL) surface over the entire Study Region to ensure that flooding through other low-lying areas is properly accounted for.

The **Shoreline Limits** dialog allows the user to perform the segmentation of the shoreline if necessary (Figure 6-33). Figure 6-34 shows the interactive map layer.

Shoreline Limits	
Optionally draw shoreline startline, endline, and brea to add a vertex and double click to finish drawing the breaklines only, right click a line to remove it.	
Current shoreline	
<pre>< Previous Shoreline</pre> 1 of 7	Next Shoreline >
Limit type	<u>ction</u>
Startline	Draw
C Endline	
Breakline U:	se Default
Car	ncel Next >

Figure 6-33: Input Shoreline Limits



Figure 6-34: Example – Setting Shoreline Limits

The user can leave the shoreline start and end as shown in Figure 6-34 or change the limit(s) (**Startline** or **Endline**) and click the **Draw** button (circled) to draw a new line on the map. The model will remove the default line and replace it with the newly drawn line. For example, Figure 6-35 shows what the user might see upon changing the **Shoreline Start** point (**Startline**).

- The user must be sure to draw the line so that it crosses the shoreline only once. This could be from inland into the flood source or from the flood source inland. The Flood Model will automatically make the line shore normal or perpendicular to the shoreline.
- Hazus allows users to zoom in or out of the map before clicking on the **Draw** button. After clicking the **Draw** button, the tool is set to the Line tool, and the customization becomes locked; therefore, users will not be able to select any other tool until the **Startline**, **Endline**, and **Breakline**(s) are drawn.

The user can move the **Startline** if the initial effort is not in the right location by merely reselecting the **Draw** button and drawing the **Startline** in another location. Similarly, if the user decides not to change the **Startline** after having drawn one, the user can click on the **Use Default** button and restore the **Startline** to its default location.

Clicking on the Use Default button (see Figure 6-35) will only restore the active Limit type, such as the Startline or the Endline. To restore both the Startline and the Endline, the user needs to select the appropriate radio button and click on the Use Default button for each line.



Figure 6-35: Example – Resetting the Shoreline Startline

Figure 6-36 shows an example of a changed **Shoreline End (Endline**). Similar to the **Startline**, the user can change the location of the **Endline** by clicking on the **Draw** button and drawing a new line. To restore the **Endline** to its default location, click on the **Use Default** button with the **Endline** radio button enabled.





As stated previously, if the Study Region geography changes along the shoreline, the user will want to segment the shoreline and classify the shoreline into the proper geophysical properties. Consult a Flood Insurance Study (FIS), identify the areas along the shoreline where the SWEL changes, and create a **Breakline** at these points. Select the **Breakline** radio button and click **Draw**. As with the **Startline** and the **Endline** drawing, draw a line crossing the shoreline only once as circled in Figure 6-37.





• The user cannot change or move a **Breakline** once it has been drawn; to remove the line, clear the **Breakline** using the **Clear All** button and redraw the **Breakline** in the new location.

After all breaklines have been drawn, click **Next** to open the **Shoreline Characteristics** window shown in Figure 6-38. The information for this window can be obtained from a FEMA FIS. Check the FEMA website for information on obtaining an effective FIS for the Study Region.

Input the SWEL in the **Elevation** field shown in the **Shoreline Characteristics** window (Figure 6-38). This field and the **Vertical Datum** field are required and will be shown in red text. The other SWEL fields are loaded with default parameters calculated using the standard FEMA ratios, but can be edited and overwritten by the user if the data are available from the FIS.

• The user should review the FIS carefully to determine whether the 100-year SWEL includes wave setup. If it does, the user should put in the 100-year SWEL as noted in the FIS, but must also check the **Yes** radio button under the **Elevation includes wave setup?** question. Doing this will enable the **Wave Setup (ft)** field. The user should enter

the wave setup value here. If the user cannot identify whether wave setup is included, quickly graph the SWELs listed in the FIS and check whether the 100-year SWEL is higher than expected by the graph. If so, it most likely includes wave setup.

After entering the Elevation and Vertical Datum for each shoreline segment, click Finish.

Shoreline Characteristics	
Current shoreline: <pre></pre>	Apply to All Segments
100-Year Flood Conditions	
100-year stillwater elevation	Other stillwater elevations (ft)
Elevation (ft): 12	10-yr: 6.4 500-yr: 12.3
Elevation includes wave setup?	50-yr: 8.8
🔘 Yes 🔿 No	Significant wave height at shore (ft)
Wave Setup (ft): 2	Depth limited 6.9 User-defined
Vertical datum	
Vertical datum: NGVD29 👻	
Other name:	
	Cancel < Back Finish

Figure 6-38: Shoreline Characterization – Stillwater Flood Conditions Window

Once the user has completed inputting the required information in the **Shoreline Characteristics** window, the Flood Model has the necessary data to perform a coastal analysis for any given return interval.

6.4.1.3 Combined Riverine and Coastal Scenario

Hazus asks the user to select between three flood hazard types in the **Flood Hazard Type** dialog (Figure 6-3) to limit the DEM requirements: **Riverine Only**, **Coastal Only**, or **Riverine and Coastal**. Selecting **Riverine and Coastal** will require the user to acquire a DEM that supports the analysis for both hazard types. Once the user provides the DEM, they can perform any of the hazard analyses.

For example, if the user selects **Riverine and Coastal**, they are required to build the **Stream Network** with the shorelines already available. While creating a scenario, the user has the option to build a scenario with only river reaches, only shorelines, or a combination of reaches and shorelines. The Flood Model maintains the riverine and the coastal hazard depth grids separately, because the depth of flooding alone does not determine which hazard is producing the most damage by occupancy.

Create a riverine and coastal flood hazard analysis within the Study Region. If necessary, first create a new Study Region. Once the Study Region is created, open it, open the **Hazard** dropdown menu and select **Flood Hazard Type**. Choose the **Riverine and Coastal** flood hazard type (Figure 6-3). See Chapter 3 to review how to create a flood Study Region and Chapter 4 for details on opening a Study Region.

If the user chooses to run a scenario with river reaches and coastal shorelines, the Flood Model will analyze the impact of both hazards on the inventory independently. It will then compare the resulting losses to determine which hazard is the controlling hazard (i.e., the hazard that has the greatest impact on that occupancy or structure).

To perform a combined analysis, the user would create a new scenario with both riverine and coastal components. After the **Create New Scenario** window (not shown), select the **River reaches** radio button (Figure 6-39). Then, select reach(es) using the **Add to selection** (+) button, and click **Save selection**. Second, select the **Coastal shorelines** radio button (Figure 6-39). Then, select the **Coastal shorelines** radio button (Figure 6-39). Then, select the **Coastal shorelines** radio button (Figure 6-39). Then, select shoreline(s) using the **Add to selection** button, and click **Save selection**. Click **OK** to ensure that both selected layers are saved. For more detailed instructions, refer to the previous sections on creating Riverine and Coastal Scenarios separately.

New Scenario	New Scenario			
Select map features to be included in the scenario. A single scenario may contain more than one object type.	Select map features to be included in the scenario. A single scenario may contain more than one object type.			
Map layer type	Map layer type			
 River reaches Coastal shorelines FIT analysis areas User-defined depth grids 	 River reaches Coastal shorelines FIT analysis areas User-defined depth grids 			
Map layer selection Add to selection Remove from selection Clear selection Save selection OK Cancel	Map layer selection Add to selection Remove from selection Clear selection Save selection OK Cancel			

Figure 6-39: Select River Reaches and Coastal Shorelines

6.4.2 Open

A user may create multiple scenarios for each Study Region. Select **Open** from the **Scenario** menu, as shown in Figure 6-40, to open a previously created scenario. The **Open Scenario** dialog will appear (Figure 6-41). Click on the scenario's name to highlight it, and then click **OK**. Only one scenario can be opened at a time.



Figure 6-40: Select Open Scenario





6.4.3 Save As

The **Save As** option under the **Scenario** menu allows users to skip the hazard analysis every time they want to run different parameters in the **Inventory** or **Analysis** menu. It saves the user time by skipping the hazard selection and rerunning the analysis. It also provides the user a way to preserve previous results without using the **Duplicate Study Region** function, which requires much more disk space. The results tables are scenario-specific and creating a new scenario using the **Save As** function assumes the user wants new results. As such, the old results are not carried over.

In addition to creating a new scenario and opening a scenario, the **Scenario** menu options shown in Figure 6-42 let the user to edit, close, or delete any created scenarios. To use the **Save As** capability, the scenario to be saved must be open. From the **Scenario** menu, select **Save As**. The **Save Scenario As** window, shown in Figure 6-43, will appear. Enter a name for the new scenario and an optional description. Click **OK** to save the old scenario and automatically open the new scenario.

NOTE: Each scenario must have a unique name.

Hazard	Analysis	Results	Bookm	narks	Insert	Selecti
Flo	od Hazard 1	ype			• 🔬	🖽 🌗
Use	er Data			AN.	x ^{₽†} ⊙ XY	0
Dev	velop Strear	n Network	·			~
Sce	nario		×		New	
Riv	erine		•		Open	
Coa	astal		•		Save As.	
Qu	ick Analysis		•		Edit	
					Close	
					Delete	

Figure 6-42: Select Save As

Enter a unique name for the S	cenario to l	be Saved A:	s:	
Description				
	_	ОК	Cance	

Figure 6-43: Enter a New Name for the Scenario

When a user modifies the inventory, all future results are affected as future analyses will
use the updated inventory. If the inventory is modified, the analysis should be rerun.
Users that plan on modifying the inventory should "duplicate" the Study Region to
compare results, otherwise the results are overwritten. The results will be overwritten if
and only if the user reruns the analysis on the same scenario.

Users that plan to modify the functions/parameters in the Damage and Loss Estimate analysis should use the **Save As** capability to compare results between scenarios, otherwise they are overwritten. The changes to damage functions are per Study Region, so the user is responsible for knowing which damage functions were used to create the results of which scenario. The user will not be able to display which damage functions were used for each scenario.

Users that plan to modify the hazard analysis do not need to use the **Save As** capability. However, a few cases must be taken into consideration:

<u>Mix grid</u>: Mix grids are created when Hazus does not know what return period to assign to the grid, such as the case of running a specific discharge analysis or assigning different return periods to different reaches in a single scenario. If a user is dealing with a mix grid case and reruns the hazard by changing some parameters (return period of one or more reaches, or the discharges), the changes to the depth grid and floodplain polygon due to this rerun will not be reflected in the loss analysis results until the loss analysis is rerun.

<u>Edits to scenario</u>: If a user reruns the hazard by adding or subtracting at least one reach from the scenario but uses the same return period, the user should rerun the loss analysis so that the results reflect the changes to the hazard.

<u>FIT/User Depth Grids/.FLT Depth Grids</u>: FIT results can only be modified in FIT. Inside the Flood Model, the only option available to the user in terms of modifying FIT/User Depth Grid/.FLT Depth Grid results is to choose which FIT Areas/User Depth Grid/.FLT Depth Grid

polygons to include in the scenario. If that kind of modification is made to the hazard, the user should rerun the flood delineation analysis so that the results reflect the changes to the hazard.

In all three cases, if the user reruns the analysis without using the **Save As** capability, the previous results will be lost.

6.4.4 Edit

The **Edit** option under the **Scenario** menu, shown in Figure 6-44, allows users to add/remove reaches to the scenario. If a user has not selected the correct reaches or shoreline, the **Edit** option allows the user to go in and re-select the correct reaches or shoreline.

Hazard	Analysis	Results	Bookm	narks	Insert	Selecti
Flo	od Hazard 1	Гуре			-	🖽 🌗
	er Data velop Strean	n Network		A	xt © xy	
	nario		۲	-	New	
Riv	erine		•		Open	
Co	astal		+		Save As.	
Qu	ick Analysis		•		Edit	
_					Close	
					Delete	

Figure 6-44: Select Edit

6.4.5 Close

The **Close** option under the **Scenario** menu, shown in Figure 6-45, closes the scenario in the mxd. The scenario is not deleted, but will not be the active scenario for any changes or updates.

Figure 6-45: Select Close

Hazard	Analysis	Results	Bookm	narks	Insert	Selecti
Flo	od Hazard T	ype			- <u>_</u>	🖽 🌗
Use	r Data			AA.	x ™ xy	0
Dev	velop Strean	n Network		-		~~~~~
Sce	nario		•		New	
Riv	erine		•		Open	
Coa	astal		•		Save As	
Qui	ick Analysis		•		Edit	
					Close	
					Delete	

6.4.6 Delete

The **Delete** option under the **Scenario** menu, shown in Figure 6-46, allows users to delete scenarios that are no longer needed. The **Delete** option allows users to delete multiple scenarios all at once by clicking on the scenarios. To use the **Delete** capability, the scenario to be deleted must be closed. Select **Delete** from the **Scenario** menu. The **Delete Scenario** dialog will appear (Figure 6-47). Select the scenario(s) to be deleted and click **OK**.

Hazard	Analysis	Results	Bookm	harks	Insert	Selecti
Flo	od Hazard T		• 🖌	🖽 🎵		
Use	er Data			AA.	x ™ xy	0
Dev	velop Strean	n Network				~~~~~
Sce	nario		×		New	
Riv	erine		×		Open	
Co	astal		+		Save As	
Qu	ick Analysis		•		Edit	
					Close	
					Delete	

Figure 6-46: Select Delete





NOTE: To delete a scenario, manually close out of all references to the scenario itself or any of the scenario directory sub-tree files, such as log files, rasters, shapefiles, personal geodatabases, and file geodatabases in either texteditor, ArcCatalog, ArcMap, or Windows Explorer. Failure to do so will result in an incorrect sync between the scenario database-related data and their file system-related objects.

6.5 Riverine

The **Hazard / Riverine** menu provides the Flood Model riverine analyses for deriving peak flows (**Hydrology**) and associated flood depths and boundaries (**Delineation Floodplain**). The Flood Model also offers the ability to simulate levees (**Levee**), impacts of fast flowing flood (**Velocity**), and flood control measures that regulate flow (**Flow Regulation**). Like other Hazus analyses, this menu requires the analyses to be performed in sequential steps. For example, Figure 6-48 shows the **Hydrology** and **Delineation Floodplain** selections active, while the other three selections are inactive.



Figure 6-48: Select Hydrology

6.5.1 Hydrology

Once the user has defined the scenario, the **Hydrology** option, on the **Hazard / Riverine** menu, becomes enabled (Figure 6-48). To conduct the hydrologic analysis, select **Hydrology** and a notification window (Figure 6-49) will warn the user that raster processing cannot be canceled. Click **Yes**.

Figure 6-49: Select Yes to Start Hydrologic Analysis



A progress bar (Figure 6-50) will appear as Hazus performs the hydrologic analysis. This may take several minutes to several hours depending on the size of the Study Region and the number of selected streams. A notification (Figure 6-51) will appear once the hydrologic analysis has been completed. Click **OK**.

Figure 6-50: Hydrologic Analysis Progress



Figure 6-51: Hydrologic Analysis Completed



6.5.1.1 Best Practices and Troubleshooting

There is a tendency for ArcMap and Hazus to experience runtime issues that can lead to the Flood Model failing to complete the analysis. Because the hydrologic analysis is specific to the Study Region and is dependent only on the river network developed by the user, there are options to reduce the possibility of the code reaching a memory limit.

Performing the hydrologic analysis on a watershed-by-watershed basis is recommended, thereby limiting the processing within the model. Here are two recommended approaches:

- 1. Create a scenario for each watershed and then perform the hydrologic analysis on each scenario. The hydrologic results are stored in a single table independent of scenario.
- 2. Create a single scenario, start with one county or watershed and perform the hydrologic analysis. When completed, edit the scenario, add the next county or watershed and rerun the hydrologic analysis. The model will skip those reaches for which the hydrologic analysis has already been performed and will perform the analysis on the added reaches. Repeat as needed to complete all watersheds in the Study Region.

For scenarios with a large number of stream reaches, running the hydrologic analysis for large areas is recommended to improve processing time. Figure 6-52 provides an example showing reaches selected for analysis (shown in red).



Figure 6-52: Select Streams for Hydrology

When running hydrologic analysis on large stream networks, continue to add streams by editing the scenario using the **Edit Scenario** dialog shown in Figure 6-53.

Edit Scenario								
Select or deselect map features included in the scenario. A single scenario may contain more than one feature type.								
Map layer type								
 River reaches 								
Coastal shorelines								
🔘 FIT analysis areas								
User-defined depth grids								
Map layer selection								
Add to selection +								
Remove from selection -								
Remove Problem Reaches								
Reset selection								
Save selection								
OK Cancel								

Figure 6-53: Edit Scenario Dialog to Add Streams

Once streams have been added into the scenario, select **Hydrology** from the Riverine menu as shown in Figure 6-54.

Hazard	Analysis	Results	Bookm	narks	Insert	Selection	Geop
Flo	od Hazard 1	Гуре			• 🔬	🖽 🇊 👼	I
	r Data velop Strear	n Network		M	1 ²⁰ xy	0 P -	
Sce	Scenario						
Riv	erine		•		Hydrolo	9y	
Coa	Coastal Quick Analysis				Delineat	te Floodplain	
Qui					Levee		
					Velocity	,	
					Flow Re	gulation	

Figure 6-54: Select Hydrology

The **Process** dialog (Figure 6-55) will appear and ask if the user wants to continue with the processing. Click **Yes** to continue. Once the hydrologic analysis has started, the process cannot be canceled.

Figure 6-55: Hydrology Processing Dialog Process The proceeding analysis requires raster processing. To ensure proper operation, canceling is not allowed. Continue? Yes No

Once the user has edited the scenario and added more streams for hydrologic analysis, the **Overwrite Existing Results** dialog will appear (Figure 6-56). If the user selects **Yes** to overwrite, Hazus will overwrite previous hydrology values, which requires more processing time. If the user selects **No**, the new results will be appended to the previous results and stored.

Figure 6-56: Overwrite Hydrology Dialog

Overwrite	Existing Results
?	The output discharge-frequency table already contains results for reaches in the current scenario. Would you like to overwrite them?
	Yes No

Hydrologic analysis is only important for performing frequency-related flood analyses (i.e., 100year return period, annualized loss, etc.). If the user wishes to apply a specific discharge to the reach(es), they should proceed directly to the **Delineate Floodplain** option on the **Riverine** menu and select **Single Discharge** (see Section 6.5.2).

When running hydrologic analysis, the Hazus screen might go blank or the Task Manager **Applications** tab will indicate that Hazus is not responding. This is a common occurrence for any process-heavy software. To see whether Hazus is still running, check the Task Manager **Processes** tab and sort the **CPU** column in descending order. The "ArcMap.exe" process should be on top. If the "System Idle Process" is constantly on top at 99–100%, Hazus is not responding. Also, check the **Performances** tab and make sure the CPU Usage is not 0 over a period of time. Another option is to open the Study Region folder (in "Details" view within Windows Explorer) and make sure the FIHydrologyLog.txt file is updating by looking at the "Date modified."

6.5.1.2 Excluding Problem Reaches from Scenario

Problem reaches are reaches for which regression equations and/or data are not available. When computing the flood hazard, analysis results for a specific return period or suite of return periods will not be available for reaches designated as Problem Reaches. Input of discharges will be required to develop the flood hazard grids for Problem Reaches.

Users have the option to set Hazus to automatically remove problem reaches (if they exist) from the scenario after the hydrologic process by selecting the **Automatically remove problem reach(es)** checkbox under **Customize** > **Flood Options** on the main Hazus menu bar, as shown in Figure 6-57.

Figure 6-57: Flood Options, Check Automatically Remove Problem Reach(es)

Flood Options
Startup Options Raster Options Automation Repository
Always show DEM (if available)
Always show computed Reaches (if available)
Open last Scenario (if available)
Show redo analyses Warning message box(es)
Automatically remove problem reach(es)
2000 CustomBuffer (default: 2000 m)

If the **Automatically remove problem reach(es)** checkbox is not selected, at the end of the hydrologic process, a **Remove Problem Reaches** message will appear, as shown in Figure 6-58, to notify the user that problem reaches exist in the scenario and to give the user the option to remove the problem reaches from the scenario (with one click of **Yes** button).

Figure 6-58: Notification and Option to Remove Problem Reaches

Remove Problem Reaches	83
This scenario contains reaches for which regression equations or data are not available. You are now given the option of having Hazus automatically remove these problem reaches from the scenario. Please note if you choose not to remove the problem reaches at this time, you will have to edit the scenario to exclude the problem reaches. You may also choose to run return period analysis by discharge. Would you like to remove all problem reaches from the current scenario at this time?	
Yes No	

If the user selects **No** in the **Remove Problem Reaches** notification, but later wishes to remove problem reaches, they can manually edit the scenario to exclude the problem reaches. This only applies to cases where the problem reaches exist in the scenario.

To manually remove problem reaches, click on the **Hazard** menu, select **Scenario**, and then click **Edit**. The **Edit Scenario** dialog will open, as shown in Figure 6-59. Click **OK**.

Edit Scenario	X
Scenario name:	
ProblemReaches	
Description]
	OK Cancel

Figure 6-59: Edit Scenario Window

Once the user clicks **OK**, all of the reaches in the scenario will be highlighted in light blue. Click the **Remove Problem Reaches** button (as shown in Figure 6-60), to remove all of the problem reaches, and then click the **Save selection** button. After the user clicks **OK**, the new scenario will be mapped, shown in Figure 6-61.



Figure 6-60: Edit Scenario Dialog to Remove Problem Reaches



Figure 6-61: Example Edited Scenario with Problem Reaches Removed

The scenario is now ready to start hydraulics (**Riverine** > **Delineate Floodplain**) for the Chosen Reaches. The hydrologic analysis does not need to be rerun because Hazus has already computed discharges for non-Problem Reaches. If the hydrologic analysis is rerun, the results will remain the same because the Problem Reaches have been removed from the scenario.

6.5.2 Delineate Floodplain

Once the hydrologic calculations are complete, the **Delineate Floodplain** option on the **Hazard** */* **Riverine** menu is enabled (Figure 6-62). Select **Delineate Floodplain** to initiate the hydraulic analysis. The **Riverine Hydraulic Analysis** dialog in Figure 6-63 will appear. Use the **Analysis Type** pull-down menu to select the type of hazard analysis to run.

Haza	ard Analysis Results Bookn	narks Insert Selection Geop
	Flood Hazard Type	
	User Data	A 🛱 🤻 🗔 💽 📮
	Develop Stream Network	
	Scenario 🕨	
	Riverine 🕨	Hydrology
	Coastal 🕨	Delineate Floodplain
	Quick Analysis	Levee
_		Velocity
		Flow Regulation

Figure 6-62: Select Delineate Floodplain

Figure 6-63: Riverine Hydraulic Analysis Dialog

Riverine Hydrauli	c Analysis		
Analysis type:	Single Return Period		▼ Fill Down
Output cell size:	Full Suite of Return P	Periods	
	Single Return Period Single Discharge		
River reaches	Single Discharge		
Reach ID	Return Period (yrs)	n-value	*
18	100	0.160	
19	100	0.160	
20	100	0.160	
24	100	0.033	
28	100	0.033	
25	100	0.160	
26	100	0.160	
			*
		ſ	OK Cancel
			OK Cancel

- Select Full Suite of Return Periods to calculate flood depths and floodplains for the 10year, 25-year, 50-year, 100-year, and 500-year return period floods on each of the stream reaches in the scenario. Starting with the 500-year return period, the Flood Model will go through each selected reach and develop a single 500-year flood depth grid. This process is duplicated for the other four return intervals. This option is required for average annualized loss.
- 2. Select **Single Return Period** to specify a return period between 2 years and 1,000 years for which the flood characteristics will be calculated. Choose different return periods for different stream reaches, if desired. Depending on the user selection, the

resultant grid will be a single return interval for all reaches selected by the user, similar to option 1 above, or a single grid of mixed return intervals for the selected reaches.

- 3. Select **Single Discharge** to input anticipated stream discharge levels for each stream reach. Similar to option 2 above, the user can enter different discharges for each reach.
 - If the user opts to run different return intervals or specific discharges for each reach in their scenario, the Transportation Bridge analysis cannot be run because the return interval for the reaches in question needs to be specified and has not been defined for a single discharge analysis.
 - The **Single Discharge** option can decrease the runtime significantly if data are available.

The final delineated floodplain should look like Figure 6-64, where only the selected reaches for the scenario have flood depth grids and boundaries delineated.



Figure 6-64: Example Riverine Hydraulic Analysis Results

6.5.2.1 Best Practices and Troubleshooting

The **Delineate Floodplain** analysis can take large amounts of time, especially when generating a flood depth grid in Hazus rather than importing a grid. Several days of processing time are possible with the **Full Suite of Return Periods** Analysis Type for an individual county. Some general guidance is listed below for the **Delineate Floodplain** analysis; however, this is not an exclusive list of best practices and troubleshooting for issues experienced during the **Delineate Floodplain** analysis. Please contact the Hazus Helpdesk (contact info in Chapter 1) for support regarding specific issues.

Blank Screen:

When running the hydraulic analysis, the Hazus screen might go blank or the Task Manager **Applications** tab will indicate that Hazus is not responding. This is a common occurrence for any process-heavy software. To see whether Hazus is still running, check the Task Manager **Processes** tab and sort the **CPU** column in descending order. The "CoreOfHydraulics.exe" process should be on top. If the "System Idle Process" is constantly on top at 99–100%, Hazus is not responding. Also, check the **Performances** tab and make sure the CPU Usage is not 0 over a period of time. Another option is to open the scenario folder (in "Details" view within Windows Explorer) and make sure the FIHydraulicsLog.txt file is updating by looking at the "Date modified."

Grid Cell Sizes:

Using a smaller cell size could dramatically increase the processing time and the size of the output raster. Resampling larger cells into smaller cells to allow a merged grid for study regions with different topographic source data may lead to issues in Hazus. The recommended approach would be to run the multiple source depth grids separately in Hazus and then combine flood loss results after all Hazus loss runs.

Reaches with Hydraulic Problems:

If running the hydraulics (i.e., **Delineate Floodplain**) is taking a long time, the hydraulic process may be hanging (i.e., getting stuck on a couple of reaches so that it cannot finish the hydraulics). The following instructions will help bypass the problem.

 Look in the log (flHydraulicsLog.txt located in Scenario folder) and note any reaches (ReachID) that have many errors and did not successfully complete processing. Example below:

•
: ReachID: 202 Core of Hydraulics
:
modLevelOne - CoreOfHydraulics: Reach 100 of 267
modLevelOne - CoreOfHydraulics: Return period: 100
modLevelOne - CoreOfHydraulics: What-if:
modLevelOne - CoreOfHydraulics: Available memory: 1631.05 mb
modInitialBuffer - InitBuffer: Reach length = 0.2 km
modInitialBuffer - InitBuffer: Reference (downstream node) discharge: 3,981 cfs
modXSections - PlaceInitXsects: Short centerline length: 964.462826043346 feet

```
modXSections - PlaceInitXsects: Buffer 3 of 9
modXSections - PlaceInitXsects: Buffer 4 of 9
modXSections - PlaceInitXsects: Buffer 5 of 9
modXSections - PlaceInitXsects: Buffer 6 of 9
modXSections - PlaceInitXsects: Buffer 7 of 9
modXSections - PlaceInitXsects: Buffer 8 of 9
modXSections - PlaceInitXsects: Buffer 9 of 9
modXSections - PlaceInitXsects: Cross section count: 3
modXSections - InitialXSectElevs: Drainage area reset from 219.9631 to 140.0594
modXSections - InitialXSectElevs: Drainage area reset from 220.2029 to 140.0594
GeometryToFeatureClass: Feature class: LeftBuffer
GeometryToFeatureClass: Feature class: RightBuffer
modGeometry - CleanPolygonIslands: Input geometry is nothing, leaving early.
ModBoundsandEnds - ValidateFloodPolygon: Error Number: 91
ModBoundsandEnds - ValidateFloodPolygon: Error: Object variable or With block variable not set
modGeometry - CleanPolygonIslands: Input geometry is nothing, leaving early.
modGeometry - IntersectABS: Input geometry #1 is invalid. No intersection.
modLimits - NewLimitsandCenterlines: Error Number: 91
modLimits - NewLimitsandCenterlines: ERROR: Object variable or With block variable not set at 8
modLevelOne - CoreOfHydraulics: Error Number: 91
modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 20
modLevelOne - CoreOfHydraulics: Error Number: 91
modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 20
modLevelOne - CoreOfHydraulics: Error Number: 91
modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 20
modLevelOne - CoreOfHydraulics: Error Number: 91
modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 20
modWsePts - FinalWsePts: Error Number: 5
modWsePts - FinalWsePts: ERROR: Invalid procedure call or argument at 2
modLevelOne - CoreOfHydraulics: WARNING: FinalWsePts failed, continuing process using points from InitialWsePts and/or
IncreaseWsePts
modLevelOne - CoreOfHydraulics: Error Number: 91
modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 45
modAddBack - AddBack: Entering
modAddBack - FillDEMMask: Error Number: 91
modAddBack - FillDEMMask: ERROR: Object variable or With block variable not set at 4
modAddBack - AddBack: Error Number: 91
modAddBack - AddBack: ERROR: Object variable or With block variable not set at 5
MakePermanent: Entering for grid: 202
MakePermanent: Path: C:\Program Files\HAZUS-MH\StudyRegion\PSchneider_NV5County\Hydraulics\Reaches\100
MakePermanent: Leaving
modAddBack - AddBack: Leaving
GeometryToFeatureClass: Feature class: 202_cl
ExportGDBFClass: Error: Featureclass Reach202ConvPGRP100 not found.
modLevelOne - CoreOfHydraulics: Leaving
```

- 2. Open the Attribute Table for the Chosen Reaches layer.
- 3. Search for the reach using the ArcID and highlight/select the problem reach.
- 4. Right click on the line of the selected reach and select **Zoom to Selected** as shown in Figure 6-65 below.

Ta	ble											x
		₽₽.	- 🔓 🌄	প্র 🚜	~						_	
_					^							
Ch	oser	nRead	hes									×
	F	ID *	Shape *	FID_	ARCID	GRID_CODE	FROM_NODE	TO_NODE	Shape_Leng	MANNINGN	Shape_Length	
		1	Polyline	0	18	14	24	16	13682.495498	0.16	13682.495498	
		2	Polyline	0	19	19	21	25	18145.845387	0.16	18145.845387	$\left \right $
H		3	Polyline	0	20	23	27	25	6504.91009	0.16	6504.91009	
H		4	Polyline	0	24	25	25	24	5707.860589	0.033	5707.860589	$\left \right $
F		5	Polyline	0	28	24	33	24	21808.312821 7307.894118	0.033	21808.312821 7307.894118	$\left \right $
H-	漸	Flas	h			20	20	27	10056.779084	0.16	10056.779084	
H,	Ð	Zoo	m To			21	50	21	10030.773004	0.10	10030.773004	
	Sen	Pan	т.									
	-											
	R.	Go 1	Fo Page									
	1	Iden	tify									
	7	Sele	ct/Unselect									
	U	Ope	Open Attachment Manager									
	₽	Zoo	m To Select	ed								
	Ø	Clea	r Selected									
		Сор	y Selected									
	×	Dele	te Selected									
	Ð.	Zoo	m To Highli	ghted								
	T.	Uns	elect Highlig	ghted		m						Þ
	T)	Rese	elect Highlig	hted		ut of 7 Selec	tod)					r
	×		te Highlight	ted		ut of 7 Selec	(eu)					
6	IUSC	шлеа	cites:			_						

Figure 6-65: Chosen Reaches Attribute Table, Zoom to Selected Reach

5. The map will now zoom into the reach selected. Zoom out of the map to locate where the selected reach is on the map (Figure 6-66). Keep in mind what the reach looks like.



Figure 6-66: Example Selected Chosen Reach (highlighted), Zoomed Out

- 6. Click on the Hazard menu, select Scenario, then click Edit.
- 7. Once the **Edit Scenario** tool is available, zoom in to the area where the problem reach is located.
- 8. Click **Remove from selection** and select the problem reach. The reach selected will be highlighted in red.
- 9. Click Save selection.
- 10. After the selection has been saved, the problem reach will be dark blue and will be excluded from the scenario.
- 11. Click **OK**.
- 12. If the scenario is a riverine/coastal scenario, the Shoreline Characterization dialog will appear after edits are made to the scenario. The original parameters that were set for the shoreline(s) are saved if the shoreline(s) wasn't added/removed from the scenario. Select the Next and Finish buttons if the existing parameters are desired.
- 13. The scenario is now ready to re-start hydraulics (Riverine\Delineate Floodplain) for the ChosenReaches. The hydraulics process will automatically rerun any reaches that did not successfully process in the previous run, skip any reaches that have been
successfully processed, and then will continue on the last reach processed. If there were any reaches where the Task Manager was used to stop Core of Hydraulics, repeat the steps to get past those reaches.

6.5.2.2 Failed Reaches

Failed reaches are reaches that have been processed in the hydraulics process, but do not produce a flood depth grid. An error message will appear to notify the user when a reach fails during the hydraulics process, as shown in Figure 6-67. Click the **Close** button and the hydraulics process will continue processing the next reach in the queue. The **FailedReaches** layer will appear on the map after the hydraulics process completes, as shown below in Figure 6-68.



oreOfHydraulics	
CoreOfHydraulics has encountered a problem an to close. We are sorry for the inconvenience.	nd needs 📑
If you were in the middle of something, the information yo might be lost.	ou were working on
For more information about this error, click here,	
Debug	Close

Figure 6-68: Example FailedReaches (purple) on Map after Hydraulics Completed



The hydraulics process should complete even if there are failed reaches. The only reason the hydraulics process will not complete is if a failed reach causes the hydraulics process to hang.

When running the analysis on a scenario with failed reaches, the analysis will only process in areas where the depth grid exists.

The Flood Model Oversight Committee identified specific items that they believed would enhance the user community acceptance of the Flood Model. These capabilities provided a level of What-if functionality to the user, allowing them to utilize the Flood Model as a planning tool. The Flood Model What-if scenarios include riverine levee, riverine flow regulation, riverine velocity, coastal long-term erosion, and coastal shore protection. The following sections provide a description of the process to generate the hazard (depth grid) for the What-if analysis.

Use of What-if scenario functionality requires that the flood hazard is already computed. Levee, flow regulation, and velocity analyses require the riverine hazard to be completed. Long-term erosion and shore protection routines require the coastal hazard to have been completed.

6.5.3 Levee

In general, DEMs are not reliable for identifying a continuous embankment with relatively small width. Grid cells are connected at the corners and the sides. As such, an embankment that is not a straight line must be at least two cells wide to be considered a barrier to flow. The Hazus levee tool allows users to:

- 1. Add a levee alignment
- 2. Attribute the levee with a level of protection
- 3. Determine the effects of a levee on flood depths within the unprotected portion of the floodplain (Level 1 analyses)

Once the **Hydrology** and **Delineate Floodplain** analyses are complete, the options for **Levee**, **Velocity**, and **Flow Regulation** on the **Hazard / Riverine** menu are enabled. The Levee tool is available to add a levee alignment, attribute the levee with a level of protection, and determine the effects of a levee on flood depths within the unprotected portion of the floodplain

To conduct a Levee analysis, select **Levee** from the **Hazard / Riverine** menu (Figure 6-69). The **Levee What-If Scenario** dialog will appear (Figure 6-70). Draw the levee by clicking the **Draw** button. Flood depth grids are already created for the reach and the user must select a grid to draw the levee alignment. The alignment should cross the floodplain twice and must not cross the stream centerline. See example in Figure 6-71. Next, enter the recurrence interval (in years between 5 and 500) that corresponds to the level of protection provided by the levee in the **Levee What-If Scenario** dialog. Click **Save**, and then **OK**.

Hazus allows users to zoom in or out of the map *before* clicking on the **Draw** button.
 After clicking on the **Draw** button, the tool is set to the Line tool, and the customization is locked; therefore, users will not be able to select any other tool until the levee is drawn.

Hazard	Analysis	Results	Bookm	iarks	Insert	Selection	Geop
Flo	od Hazard T	ype			- 1	🖽 🇊 👼	D
Use	r Data			AA.	anta ang	0 🗨 -	
Dev	velop Strean	n Network.		-			
Sce	nario		•				
Ri∨	erine		•		Hydrolo	9Y	
Co	astal		•		Delineat	e Floodplain	
Qu	ick Analysis		•		Levee		
					Velocity		
					Flow Re	gulation	

Figure 6-69: Select Levee

Figure 6-70: Levee Dialog

🕓 Levee What-If Scenario 🛛 🔀
Draw a levee polyline and assign a level of protection. To draw, single click to add a vertex and double click finish to drawing. Repeat to add additional levees.
Draw Levee Shape
Level of Protection
Year
OK Cancel



Figure 6-71: Example Riverine Levee

The model then inserts the levee into the DEM and the flood hazard for the scenario is recomputed.

6.5.4 Velocity

The velocity of floodwater contributes to the flood hazard by carrying large amounts of sediment and debris. This acts to impact structures and erode soil from stream banks and foundations. The velocity analysis estimates the spatial distribution of the floodwater velocities into general categories of low, medium, and high, but does not estimate an actual velocity value.

To conduct a riverine flow velocity analysis, select **Velocity** from the **Hazard / Riverine** menu (Figure 6-72).

Hazard	Analysis	Results	Bookm	arks	Insert	Selection	Geopi
Flo	od Hazard T	ype		-	- 1	🗉 🇊 👼	I
Use	er Data			AA.	2 ²⁰ 0	0 🗨 -	
Dev	velop Strean	n Network					
Sce	nario		•				
Riv	erine		•		Hydrolo	gy	
Co	astal		•		Delineat	e Floodplain:	
Qu	ick Analysis		•		Levee		
					Velocity		
					Flow Re	gulation	

Figure 6-72: Select Velocity

The **Process** dialog (not shown) will appear and ask if the user wants to continue with the processing. Click **Yes** to continue. Once the velocity analysis has started, the process cannot be canceled.

6.5.5 Flow Regulation

The default hydrologic analyses apply to unregulated drainage areas. Regulation, through diversions and/or storage, changes the flood frequency curves downstream. Hazus provides a tool for incorporating the downstream effects of flow regulation. The tool allows users to modify the unregulated flood frequency curve at a specific location by entering one or more pairs of recurrence intervals and discharge values. Hazus identifies downstream reaches affected and modifies the corresponding flood frequency curves as appropriate, prior to re-computing the flood hazard.

Select **Flow Regulation** from the **Hazard / Riverine** menu (Figure 6-73). The **Flow Regulation** dialog will appear as shown in Figure 6-74. Click the **Draw** button to identify the location of a regulating structure, such as a flood control reservoir. Click a spot on the map to designate the location of this structure. Next, click **Apply**. Once the **Apply** button is clicked, the algorithm finds the drainage area upstream of that location and defines the unregulated flood frequency curve. The curve is plotted and a table of recurrence intervals and associated discharge values is presented for the user. Enter the **Return Period** and **Discharge** of the regulating structure in the **Flow Regulation** dialog and click **OK**.

• Hazus allows users to zoom in and out of the map before clicking on the **Draw** button. After clicking on the **Draw** button, users will not be able to select any other tool until the regulation structure is drawn.

Hazard Analysis Results Bo	ookn	narks	Insert	Selection	Geop	rocessing
Flood Hazard Type			- 1	÷ 🔍	Q 200	1 🥥 X K
User Data		41-	*IN	山中ン	< Q	
Develop Stream Network		-				
Scenario	•					
Riverine	•		Hydrolo	ду		
Coastal	►		Delineat	e Floodplai	n	
Quick Analysis	►		Levee			
			Velocity			
			Flow Reg	gulation		

Figure 6-73: Select Flow Regulation

The **Process** dialog (not shown) will appear and ask if the user wants to continue with the processing. Click **Yes** to continue. Once the velocity analysis has started, the process cannot be canceled.





6.6 Coastal

The **Hazard / Coastal** menu (Figure 6-75) provides the Flood Model coastal analyses for deriving flood depths and boundaries (**Delineation Floodplain**) associated with the coastal flood elevations and shoreline segments entered when defining the scenario. The selections for **Long Term Erosion** and **Shore Protection** are unavailable in the current version of Hazus. Therefore, the selections are disabled by design and will not be covered in this User Manual.



Figure 6-75: Select Delineate Floodplain

6.6.1 Delineate Floodplain

To delineate the floodplain, select **Delineate Floodplain** from the **Hazard / Coastal** menu (Figure 6-75). The **Coastal Hazard Analysis** dialog will open (Figure 6-76). This dialog allows the user to select from two coastal analysis options:

- If the user selects Full Suite of Return Periods from the Analysis Type drop-down menu, Hazus will calculate flood depths and floodplains for the 10-year, 25-year, 50year, 100-year, and 500-year return period floods for the entire shoreline in the scenario. The Flood Model will produce a single flood depth grid for the shoreline for each of the five return intervals.
- 2. If the user selects **Single Return Period** from the **Analysis Type** drop-down menu, the user can specify any flood return period between 10 and 500 years for which the flood characteristics will be calculated. Unlike the riverine hazard, the user cannot choose different return periods for different shoreline segments. The Flood Model will produce a single flood depth grid for the shoreline for the selected return period.

Analys	sis type:	Single Return Period		•	Fill All
Output	cell size: (26.2175977449504			
Coasta	al Shorelines				
	Shore ID	Return Period (yrs)			
	2	100			
	3	100			
	3 4	100			
	5	100	Ξ		
	2 3 4	100			
	7	100			
	1	100			
	1	100	-		
•			•		
		35 mb. Estimated use: 240			

Figure 6-76: Coastal Hazard Analysis Dialog

6.6.2 Best Practices and Troubleshooting

Coastal floodplain delineation in the Flood Model is much less likely to have issues than riverine analysis. However, memory issues can still influence a larger coastal analysis. At the bottom of the **Coastal Hazard Analysis** window (Figure 6-76), Hazus indicates how much virtual memory is available on the machine and the estimated virtual memory that will be used for the coastal analysis. When running the coastal flood delineation analysis, the Hazus screen might go blank or the Task Manager **Applications** tab will indicate that Hazus is not responding. This is a common occurrence for any process-heavy software. To see whether Hazus is still running, check the Task Manager **Processes** tab and sort the **CPU** column in descending order. The "ArcMap.exe" process should be on top. If the "System Idle Process" is constantly on top at 99–100%, Hazus is not responding. Also, check the **Performances** tab and make sure the CPU Usage is not 0 over a period of time. Another option is to open the scenario folder (in "Details" view within Windows Explorer) and make sure the FICoastalLog.txt file is updating by looking at the "Date modified."

6.7 Quick Analysis

The **Hazard / Quick Analysis** menu (Figure 6-77) provides two additional types of low-quality flood analysis: **Quick Look** and **Enhanced Quick Look**. Chapter 13 provides detailed step-by-step instructions on conducting both types of analysis.

Hazard	Analysis	Results	Bookm	narks	Insert	Selection	Geopro
Flo	od Hazard T	ype			• <u>s</u>	🖽 🇊 👼	💿 🗅
Use	r Data			AA.	at or	o I 🗨 🚽	
Dev	velop Strean	n Network.			-0 AT -		
Sce	nario		×				
Riv	erine		•				
Coa	astal		•				
Qu	ick Analysis		×		Quick L	ook	
					Enhance	ed Quick Loc	k

Figure 6-77: Select Quick Look

6.7.1 Quick Look

The **Quick Look** feature allows the user to quickly produce a rough estimate of flood damages, without working through the process of generating a stream network or delineating a floodplain. Instead of generating a floodplain associated with a specific return period or rainfall amount, **Quick Look** lets the user enter an anticipated flood depth for an area of their selection. Then, based on the infrastructure present in the area, Hazus estimates approximate damages.

The **Quick Look** analysis is only performed on the GBS. The GBS results tables are populated and a summary report uniquely developed for the **Quick Look** is populated. This restriction was imposed to prevent users from attempting to perform a detailed analysis of a specific site using this crude method of analysis.

Quick Look is only appropriate for small areas with similar elevations. The **Quick Look** function assumes a standard depth of water over the entire area selected, and does not use any topography\DEM or check for the veracity of the flood depths input by the user. If an area with significant elevation gradations has been selected, **Quick Look** will assume that high elevation locations have the same level of flood depth as low elevation locations, which would produce meaningless results. **Quick Look** does allow the user to create multiple polygons with differing flood depths.

To perform a **Quick Look** analysis, select **Quick Look** from the **Hazard / Quick Analysis** menu (Figure 6-77). This functionality will not work if the user has already opened a scenario. Click on **Draw** in the **Quick Look** dialog that appears. Using the cursor, draw a polygon with as many sides as desired, as illustrated with the yellow line in Figure 6-78. Double-click when the polygon is complete. Next, enter a **Flood Depth** for the polygon in the **Quick Look** dialog. Click **Save**, then click **OK**.



Figure 6-78: Drawing a Polygon for Quick Look

 Only one Quick Look analysis can be performed in a given Study Region. Additional Quick Look analysis efforts will overwrite the results from the previous analysis. Quick Look will not run if a scenario is open. It is independent from the scenario(s).

6.7.2 Enhanced Quick Look

Similar to the **Quick Look** function, the **Enhanced Quick Look** analysis option allows the user to draw a polygon that represents the floodplain boundary and the DEM for the region. Hazus will estimate the flood depth within that boundary. **Enhanced Quick Look** does not establish a flow regime. Therefore, the analysis is based on the user-supplied anecdotal information and should be used with great care.

Select Enhanced Quick Look from the Hazard / Quick Analysis menu (Figure 6-77). The Enhanced Quick Look window will appear (Figure 6-79). Select the Vertical units and Vertical datum of the polygon from the dropdown menus. Browse to the appropriate locations for the DEM and single continuous floodplain boundary polygon, as illustrated in Figure 6-79. Click OK to start the analysis.

Enhanced Quick Look	
Enhanced Quick Look	
DEM metadata	
Vertical units	
Vertical datum	
Other vertical datum	
Select DEM dataset location	
	Browse
	Show
Floodplain Boundary Locatio	
	Browse
Full damage	Show
	OK Cancel

Figure 6-79: Enhanced Quick Look Window

Only one **Enhanced Quick Look** analysis can be performed in a given Study Region. Additional **Enhanced Quick Look** analysis efforts will overwrite the results from the previous analysis. **Enhanced Quick Look** will not run if a scenario is open. It is independent from the scenario(s).

The **Enhanced Quick Look** analysis is only performed on the GBS. The GBS results tables are populated and a summary report uniquely developed for the **Enhanced Quick Look** is populated. This restriction was imposed to prevent users from attempting to perform a detailed analysis of a specific site using this crude method of analysis.

See Chapter 13 for step-by-step instructions on how to perform **Quick Look** and **Enhanced Quick Look** analyses.

7 Model Menu: Analysis

After Hazus has calculated the hazards, it will need to run the loss analysis to provide damage estimates using the **Analysis** menu (Figure 7-1). As with other Hazus Flood Model menus, items grayed out represent functionality not currently available given the type of analysis being conducted and the completion of required prerequisite analysis steps.

In a Hazus loss analysis, the characteristics of the structures and people of the Study Region are analyzed for vulnerability to the flood or floods that have been calculated in the scenario. Default depth damage functions, which estimate percent damage relative to the depth of floodwater as measured from the top of the first finished floor (riverine) or bottom of the first floor (coastal), are provided within the Hazus program. Other damage functions are also included in the Flood Model to estimate damages to vehicles, agriculture, utility components, and transportation bridges.

Ana	alysis	Results	Bookmarks	Insert
	Dam	iage Funct	ions	•
	Rest	oration Fu	nctions	•
	Para	meters		•
	Floo	d Warning		
	Aver	age Annu	alized Loss	
	Com	bined Wir	nd and Flood	
	Quic	k Analysis		
	Run			

Figure 7-1: Analysis Menu

7.1 Damage Functions

The **Analysis** menu options reflect the functions that will be used to estimate damage of various types. This section discusses the options on the **Analysis / Damage Functions** menu.

Analysis Results Bookmarks	Insert	t Selection Geoprocessing Cus
Damage Functions	•	Buildings
Restoration Functions	•	Essential Facilities
Parameters	•	Transportation Systems
Flood Warning		Utility Systems
Average Annualized Loss		Agricultural Products
Combined Wind and Flood		Vehicles
Quick Analysis		
Run		

Figure 7-2: Analysis / Damage Functions Menu

Select **Buildings** from **Analysis / Damage Functions** menu. The **General Building Stock Depth-Damage Functions** table shown in Figure 7-3 will appear. The **Structure** table provides information on the default damage function associated with each specific occupancy class (e.g., RES1) and subclass (e.g., RES1, 1 story, no basement). Scroll to the right to see the percent of damage, expressed in terms of building replacement cost, estimated at different water depths. The pull-down menus at the top of the window allow the user to view the default damage functions for the flood hazard types (V zone, coastal A zone, and riverine) and other occupancy classes (e.g., COM1, AGR1, IND1). Click on the different tabs at the top (**Structure, Contents**, **Inventory**) to view default damage functions associated with building structures, and their contents, for all specific occupancy types and inventory for selected occupancies (e.g.,COM1, IND1-6, AGR1).

	General Buildi	ing Stock Depth-Da	mage Functions					x
	hushus o i			-				
5	tructure Conte	ents Inventory						
			Static c2					
	Riverine	•	RES1	-				
	•			·				
		-		-				_]
		Occupancy Incod	SpecificOccupId B11N	Source	Description	Stories		4
	1	RES1 RES1	R11B	USACE - IWR BCAR - Jan 2011	one story, no baseme one story, w/ baseme		R/	
	2	RES1	R12N	FIA	two floors, no baseme		P	
	4	RES1	R128	FIA (MOD.)	two floors, w/ baseme			
	5	RES1	R13N	FIA	three or more floors, n			
	6	RES1	R13B	FIA (MOD.)	three or more floors, v			
	7	RES1	R1SN	FIA	split level, no baseme			
1	8	RES1	R1SB	FIA (MOD.)	split level, w/ baseme			11.1
								-
								-
							4	
	•						•	Ŧ
	Library					Close	Print	
				_	L			

Figure 7-3: Building Depth-Damage Functions by Occupancy (Riverine) Table

Click on the **Library** button in the lower left corner of the **Building Stock Depth-Damage Functions** window. The **Structure Damage Functions** library shown in Figure 7-4 will appear. Viewing the library of damage functions allows the user to review other damage functions applicable to the occupancy under consideration relative to the current default, as well as replace the current default with another function from the library.

	cupancy: RESI		-		-4 ft		2.ft -1.f		1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	7 ft	8 ft	9 ft	1
4	specificOccupId	Stories	Basement 🔺	1	0.00		0.00 3.		23.00	32.00	40.00	47.00		59.00	63.00	67.00	71.00	
1	B11N	1 Story	Buschichk	2	0.00	0.00	0.00 0.	00 18.00	22.00	25.00	28.00	30.00	31.00	40.00	43.00	43.00	45.00	4
2	B11B	1 Story		3														_
3	B12N	2 Story		-														
4	R12B	2 Story																
5	R13N	3 Story				JSACE - IV		~	ent Sourc					elected S				
6	R13B	3 Story	V	Default	t Source: (JSACE - IW	VR	Cum	ent Sourc	e: FIA			5	elected 5	ource:			
7	R1SN	Split Level																
8	R1SB	Split Level	V															_
				-		upancy		iurce		amageFn		ID			comme	ent		•
					RES1		FIA			or, no ba:			05					
				2	RES1		USACE -			ry, no ba			32					_
				3	RES1			Galveston		ry, no ba			39					_
				4	RES1		USACE -			ry, no ba			29					_
				5	RES1			New Orlear					42					_
				6	RES1			New Orlear					41					_
				7	RES1			New Orlea					53					_
				8	RES1			New Orlean					44					_
				9	RES1			New Orlear					43					_
				10	RES1			New Orlean					54					_
				11	RES1			New Orlean					50					-
					RES1			New Orlean		P .			49					_
				13	RES1 BES1		USACE -	St. Paul Wilmington		ry, Struct			73 78					
			T	14	IBEST		IUSALE -	Wilminaton	Lone sto	ru. Pile to	oundai		/8					Þ
			•											_			_	_

Figure 7-4: Building Depth-Damage Function Library

The Library uses color codes to help the user identify any changes and selections they may make in the dialog. The Library dialog comprises three windows.

The left window is the navigation window where the user can change between occupancies, foundation heights, and number of stories. This window allows the user to select a specific occupancy (e.g., RES1) and shift through the potential foundation types (slab on grade, fill, basement, crawlspace, pier, post, and pile) and number of stories typical for the selected specific occupancy (1 story, 2 story, 3 story, split level for residential and low-, mid-, and high-rise for non-residential) within that occupancy. The sub-occupancies displayed in the window (shown in the first column) are a form of shorthand that identifies the occupancy class. The short hand was developed by taking the first letter and numeric values of the specific occupancy name (e.g., RES1 becomes R1 and COM10 become C10); this is concatenated with the value for the number of stories (e.g., 2 story becomes 2 and low rise becomes L), and finally the existence of a basement derives the last value (e.g., structures with a basement get a B and structures without a basement get an N). Therefore, the residential occupancy classified as RES1 with 1 story and no basement becomes R11N while the commercial occupancy classified as COM10, mid-rise, with a basement becomes C10MB.

The bottom right window is where the library of damage functions is displayed for the user to view and/or select. The user can browse between damage functions for the foundation and number of stories by selecting the sub-occupancies in the left column grid. In this case, Figure

7-4 displays all of the functions available for the sub-occupancy R11N (RES1, 1 Story, with no basement). Selection of C10MB (COM10, mid-rise, with basement) would display an entirely different set of damage functions in the grid on the lower right.

Finally, the window in the upper right allows the user to make comparisons and selections among the damage functions. The first row in the grid will always display the Hazus default function in red. The second line in the upper right grid displays the "current" function or any damage function that the user has highlighted in the lower window. To help the user view the current function, it is also displayed in green text. The user may want to use the "current function" line as a way of displaying a function and directly comparing it to the default damage function. Figure 7-4 displays a U.S. Army Corps of Engineers (USACE) New Orleans District damage function (highlighted row 10) for RES1, 1 story, slab on grade. The third row in the upper right grid displays any function the user may have "selected" as their damage function. That is, a damage function the Flood Model will use rather than the default damage function. This is how the user can override the default damage functions with either a library function that they believe better represents the local area or a custom function they have built themselves as described below.

Figure 7-5 displays a USACE New Orleans District damage function (lower right grid, blue text RES1, 1 story, pier foundation) that was selected in place of the default function. If the user chooses, they may use one of the library functions to build their own custom damage function. To do this, click the **User Defined** button in the lower left corner of the dialog. When the user selects this button, the Flood Model takes the highlighted damage function, if any, and opens an editable dialog (Figure 7-6) for the user to make modifications. The Flood Model inserts the damage function description from the starting damage function the user selected (or the default damage function. This allows the user to remember where they started the process. The user is required to enter a source (or name) for the damage function. Editing of the **Enter Comment** or **Enter DmgFn Description** fields is not recommended.

00	cupancy: RESI		-		-4 ft		2 ft -1		1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	7 ft	8 ft	9 ft	10
4	specificOccupId	Stories	Basement 🔺	1	0.00			.00 13.00	23.00	32.00	40.00	47.00	53.00	59.00	63.00	67.00	71.00	73
1	B11N	1 Story	Dubbillorik	2	0.00	0.00	0.00 0.	.00 18.00	22.00	25.00	28.00	30.00	31.00	40.00	43.00	43.00	45.00	46
2	R11B	1 Story	V	3						_								_
3	B12N	2 Story		4														
4	R12B	2 Story	V															
5	R13N	3 Story		Defende	C	JSACE - IW	'n		ent Source	514				elected 9				
6	R13B	3 Story	V	Derault	Source: (DOACE - IW	n in	Lum	ent pourci	e: FIA			5	elected 3	ource:			
7	R1SN	Split Level																
8	R1SB	Split Level	V															_
				▲		upancy		ource		mageFn		ID			comme	ent		-
					RES1		FIA		one floo				05					
				2	RES1			Chicago	one stor	<i>v</i> · ·			32					_
				3	RES1			Galveston	one stor				39					_
				4	RES1		USACE		one stor				29					_
				5	RES1			New Orlea				1.						_
				6	RES1			New Orlea				1						_
				7	RES1			New Orlea					53					_
				8	RES1			New Orlea					44					_
				9	RES1			New Orlea					43					_
				10	RES1			New Orlea				1!						
				11	RES1			New Orlea					50					
					RES1			New Orlea					49					
					RES1 BES1			St. Paul	one stor				73 78					-
_							TUSELE -	- securation	Lone stor	u rie to	unna		(8)					
			•															

Figure 7-5: Building Depth-Damage Function Library User-Defined Option

Figure 7-6: Editing Dialog for User-Defined Function Development

User Defined Library																	×
			i tories: [1 St			ement		inter Sou									
Enter DmgFn Description: Enter Percent Damage	one floor, no ba	asement, Struc	ture, A-Zoni	•			En	er Comm	ient: (St	arted from	n FIA)						
-4 ft -3 ft 1 0.00 0.00	-2 ft -1 ft 0.00 0.00	0 ft 1 ft 18.00 22.		3 ft 28.00	4 ft 30.00	5 ft 31.00	6 ft 40.00	7 ft 43.00	8 ft 43.00	9 ft 45.00	10 ft 46.00	11 ft 47.00	12 ft 47.00	13 ft 49.00	14 ft 50.00	15 ft 50.00	14
															эк	C	ancel

If the user has decided to select a new damage function for use in the Flood Model, the entry dialog will highlight the damage function to remind the user that a default function is not being used. Figure 7-7 shows how the change would appear in the entry dialog as compared to that shown earlier in this section in Figure 7-3 using a User-Defined Depth-Damage Function.

Figure 7-7: Building Depth-Damage Function Dialog with a User-Defined Damage Function

		Static c2				
Riverine	•	RES1	-			
		o ** o ++		D	o	
1	Occupancy RES1	SpecificOccupId B11N	Source USACE - IWR	Description one story, no baseme	Stories	
1	REST	B11N	User Defined	one floor, no basemer		(SI
3	REST	R11B	BCAR - Jan 2011	one story, w/ baseme		B/
4	REST	B12N	FIA	two floors, no baseme		
5	REST	R12B	FIA (MOD.)	two floors, w/ baseme		
6	RES1	R13N	FIA	three or more floors, n		
7	RES1	R13B	FIA (MOD.)	three or more floors, w		
8	RES1	R1SN	FIA	split level, no baseme		
9	RES1	R1SB	FIA (MOD.)	split level, w/ baseme		+
1	m					

Similar default damage functions are available for other facilities from the **Damage Functions** menu, as shown in Figure 7-8 below. The damage function dialogs for **Essential Facilities** function in the same way as those discussed above for the **General Building Stock**. In most cases, the damage functions available in the **Essential Facilities** dialog area also available for the Government structures in GBS. The **Essential Facilities** dialog does not have an inventory tab because the Essential Facilities occupancies do not produce inventory for sale.

Ana	alysis	Results	Bookmarks	Inser	t	Selection	Geoprocessing	Cust
	Dam	iage Funct	ions	►		Building	gs	
	Rest	oration Fu	nctions	•		Essentia	Il Facilities	
	Parameters			•		Transpo	ortation Systems	
	Floo	d Warning				Utility S		
	Aver	age Annu:	alized Loss			Agricult	tural Products	
	Com	- bined Wir	nd and Flood			Vehicles	5	
	Quic	k Analysis			Γ	N I		
_	Run		_			V		

Figure 7-8: Analysis / Damage Functions Menu

The **Transportation Systems** damage function dialog looks slightly different as there is only a structure damage function (no contents or inventory) and the dialogs tabs allow the user to shift between highway, railway, and light rail facilities.

- Currently, the Flood Model has damage functions for bridges only related to highway, railway, and light rail facilities.
- The **Transportation Systems** damage functions for bridges are based on return period. An analysis cannot be performed on bridges if the user assigns mixed return periods on the selected reaches. In other words, if the user assigns a different return period to each reach, or a single discharge on the reaches, the Flood Model will not be able to analyze the bridges.

Figure 7-9 shows the **Damage Functions for Transportation System** table, which has the same table columns for highway, railway, and light rail facilities.

lighway Dar	nage					
	Occupancy	SpecificOccupId	Source	Description	ScourPotential	T
1	HWB1	HWB1SU	HazusDflt	Continuous Span	U	- (
2	HWB1	HWB1S1	HazusDflt	Continuous Span	1	(
3	HWB1	HWB1S2	HazusDflt	Continuous Span	2	(
4	HWB1	HWB1S3	HazusDflt	Continuous Span	3	- (
5	HWB2	HWB2SU	HazusDflt	Continuous Span	U	
6	HWB2	HWB2S1	HazusDflt	Continuous Span	1	- (
7	HWB2	HWB2S2	HazusDflt	Continuous Span	2	- (
8	HWB2	HWB2S3	HazusDflt	Continuous Span	3	- (
9	HWB3	HWB3SU	HazusDflt	Single Span	U	
10	HWB3	HWB3S1	HazusDflt	Single Span	1	
11	HWB3	HWB3S2	HazusDflt	Single Span	2	
12	HWB3	HWB3S3	HazusDflt	Single Span	3	
13	HWB4	HWB4SU	HazusDflt	Single Span	U	1
14	HWB4	HWB4S1	HazusDflt	Single Span	1	
15	HWB4	HWB4S2	HazusDflt	Single Span	2	1
16	HWB4	HWB4S3	HazusDflt	Single Span	3	1
17	HWB5	HWB5SU	HazusDflt	Continuous Span	U	
18	HWB5	HWB5S1	HazusDflt	Continuous Span	1	
19	HWB5	HWB5S2	HazusDflt	Continuous Span	2	
20	HWB5	HWB5S3	HazusDflt	Continuous Span	3	
21	HWB6	HWB6SU	HazusDflt	Continuous Span	U	1
22	HWB6	HWB6S1	HazusDflt	Continuous Span	1	- (
23	HWB6	HWB6S2	HazusDflt	Continuous Span	2	1
ا						h.

Figure 7-9: Transportation Damage Function Table

Figure 7-10 shows the **Damage Functions For Utility System** table. As with the **Transportation Systems**, the tabs allow the user to choose the utility type for review.

otable Water	Waste Water Oil	Natural Gas Electric	Power Communic	ations		
Potable Wat	er Damage					
	0 Occupancy	SpecificOccupId	Source	Description	EquipmentHt	
1	PDFLT	PDFLT	Hazus Dflt		3	
2	PPPL	PPPL	Hazus Dflt	Large Pumping Plant	3	Er
3	PPPM	PPPM	Hazus Dflt	Medium Pumping Plar	3	Er
4	PPPS	PPPS	Hazus Dflt	Small Pumping Plant I	3	Er
5	PSTAS	PSTAS	Hazus Dflt	Elevated Tanks	80	
6	PSTBC	PSTBC	Hazus Dflt	Buried Concrete Tank	3	Ve
7	PSTGC	PSTGC	Hazus Dflt	At Grade Concrete Ta	0	Τa
8	PSTGS	PSTGS	Hazus Dflt	At Grade Steel Tank	0	Τa
9	PSTGW	PSTGW	Hazus Dflt	At Grade Wood Tank	0	Τa
10	PWE	PWE	Hazus Dflt	Wells	3	As
11	PWTL	PWTL	Hazus Dflt	Large Gravity or Oper	3	Sc
12	PWTM	PWTM	Hazus Dflt	Medium Gravity or Op		Sc
13	PWTS	PWTS	Hazus Dflt	Small Gravity or Open	3	Sc
14	PCVS	PCVS	Hazus Dflt	Control Vaults and Co	0	Er
						ŀ

Figure 7-10: Utility Facility Damage Function Table

The Damage Functions For Agriculture Products table shown in Figure 7-11 is similar to the General Building Stock Depth-Damage Function table, but has been modified to support the different crops available to the user. The Flood Model team gathered a number of damage functions from the USACE for various crops. The total number of damage functions available were limited and in some cases functions had to be created to allow the users to work with the top agricultural crops within each state. The damage functions are based on a Julian calendar system. For the user's convenience, the Flood Model makes the conversion between the standard calendar day and month to the Julian date. The user must provide the date either in the Analysis / Parameters / Agricultural menu or in a popup window after the agricultural analysis has been started. This process is described in Section 7.3.

The Flood Model assumes a short duration, slow rise flood when analyzing losses. Agriculture crops are particularly sensitive to duration and the functions obtained from the USACE have

damage modifiers (visible by scrolling to the right) that allow for the estimation of flood damages should the flood last 0 days, 3 days, 7 days, and 14 days. The damage functions defaults in the Flood Model assume that the maximum damage is obtained at the 14-day interval.

гор Туре:					
Alfalfa Hay	-	•			
	Сгор	Source	JulianDay	PercentDamagetoCrop	DurationModifi
1	Alfalfa Hay	USACE	1	37.00	
2	Alfalfa Hay	USACE	2	37.00	
3	Alfalfa Hay	USACE	3	37.00	
4	Alfalfa Hay	USACE	4	37.00	
5	Alfalfa Hay	USACE	5	37.00	
6	Alfalfa Hay	USACE	6	37.00	
7	Alfalfa Hay	USACE	7	37.00	
8	Alfalfa Hay	USACE	8	37.00	
9	Alfalfa Hay	USACE	9	37.00	
10	Alfalfa Hay	USACE	10	37.00	
11	Alfalfa Hay	USACE	11	37.00	
12	Alfalfa Hay	USACE	12	37.00	
13	Alfalfa Hay	USACE	13	37.00	
14	Alfalfa Hay	USACE	14	37.00	
15	Alfalfa Hay	USACE	15	37.00	
16	Alfalfa Hay	USACE	16	37.00	
17	Alfalfa Hay	USACE	17	37.00	
18	Alfalfa Hay	USACE	18	37.00	
19	Alfalfa Hay	USACE	19	37.00	
20	Alfalfa Hay	USACE	20	37.00	
21	Alfalfa Hay	USACE	21	37.00	
1	A 16-16- 1 1	LICACE		00.50	- F

Figure 7-11: Agriculture Products Damage Function Table

Figure 7-12 shows the **Damage Functions For Vehicles** table.

er Car ABS Default Damage to car from Ir 1.50 ck ABS Default Damage to light truck 2.70 uck ABS Default Damage to heavy truc 5.00
ck ABS Default Damage to light truck 2.70 uck ABS Default Damage to heavy truc 5.00 ✓
uck ABS Default Damage to heavy true 5.00 🔽

Figure 7-12: Vehicle Damage Functions Table

7.2 Restoration Functions

The Flood Model provides restoration functions for GBS and Essential Facilities. The GBS restoration functions are discussed in the **Analysis / Parameters** menu discussion, as the GBS values are included in the **Direct Economic** parameter tables. Built from the restoration timelines for the related GBS occupancies, the Essential Facilities restoration models provide the user with a general indication of the *maximum* restoration time for 100 percent operations. Obviously, there will be a great deal of effort to quickly restore Essential Facilities to full functionality and therefore this will be an indication of the maximum downtime.

Selecting **Essential Facilities** from the **Analysis / Restoration Functions** menu (Figure 7-13) opens the dialog shown in Figure 7-14. In this case, the figure shows the dialog on the **Medical Care Facilities**_tab. The **Restoration Functions** are editable and the user can adjust the

MaxDaysToRestoration column and the **FunctionalDepth** column (scroll to the right). These values are based on the depth of flooding at the specific facility (the latitude and longitude).

Ana	lysis Results Bookmarks	Inser	t	Selection	n	Geoprocessin	g Cust
	Damage Functions	►		🖽 🎵	7	🔊 🚬 🗫	
	Restoration Functions	•		Essen	itial	Facilities	
	Parameters	×		Trans	po	rtation Systems	
	Flood Warning			Utility	y Sy	/stems	
	Average Annualized Loss		F	7			
	Combined Wind and Flood			<u> </u>	_		
	Quick Analysis			- N	ļ		
	Run			3			

Figure 7-13: Analysis / Restoration Functions Menu

Figure 7-14: Essential Facilities Restoration Functions Table

Medical Care	Facilities				
	EssntFltyClass	FltyDescription	MinimumDepth	MaximumDepth	MaxDaysToRestoratic
1	EFHL	Large Hospital (greater th	-4	0	
2	EFHL	Large Hospital (greater th	0	4	
3	EFHL	Large Hospital (greater th	4	8	
4	EFHL	Large Hospital (greater th	8	25	
5	EFHM	Medium Hospital (50 to 1	-4	0	
6	EFHM	Medium Hospital (50 to 1	0	4	
7	EFHM	Medium Hospital (50 to 1	4	8	
8	EFHM	Medium Hospital (50 to 1	8	25	
9	EFHS	Small Hospital (less than	-4	0	
10	EFHS	Small Hospital (less than	0	4	
11	EFHS	Small Hospital (less than	4	8	
12	EFHS	Small Hospital (less than	8	25	
13	EFMC	Medical Clinics and Labs	-4	0	
14	EFMC	Medical Clinics and Labs	0	4	
15	EFMC	Medical Clinics and Labs	4	8	
16	EFMC	Medical Clinics and Labs	8	12	
17	EFMC	Medical Clinics and Labs	12	25	
18	MDFLT	Default for Medical	-4	0	
19	MDFLT	Default for Medical	0	4	
20	MDFLT	Default for Medical	4	8	
21	MDFLT	Default for Medical	8	25	
4		III			

7.3 Parameters

There are several parameters the user may want to view and/or modify before starting the analysis. In one case, **Agriculture**, the user is required to input a value before the Flood Model can perform the analysis. This section walks the user through the available parameters. Every effort has been made to provide default values wherever possible, which allow the model to perform most requested analysis without user intervention.

The Analysis / Parameters menu appears in Figure 7-15. The menu provides access to the default parameters used in the analysis of Fire Following Flood, Debris, Casualties, Shelter, Agriculture, Direct Economic, Lifelines Economic, and Indirect Economic.

The **Casualties** menu item opens a word document that provides the user with some guidance on the natural average for casualties. The Flood Model does not provide estimates for floodrelated casualties.

The **Fire Following Flood**, **Lifelines Economic**, and **Indirect Economic** analyses are all currently inactive in Hazus and will not be described in this version of the user manual.



Figure 7-15: Analysis / Parameters Menu

Selection of the **Debris** menu item opens an editable **Debris Parameters** dialog (Figure 7-16) that allows the user to view the default debris values. Debris is estimated based on the depth of flooding within the structure, similar to the estimation of GBS damage, specific occupancy, and whether the foundation has a footing or a slab. The user can use the combo boxes to shift between specific occupancies and the foundation types.

Debris is estimated in three main classifications that align loosely with the earthquake models method of classification: finishes (dry wall, flooring, insulation, etc.), structure (framing, walls, exterior cladding), and foundation weight (concrete slab, concrete block, or other foundation). Unlike the earthquake model, where moderate damage may still result in the foundation being removed, flooding requires the structure to be considered substantially damaged before the foundation is removed. The weights are in tons per thousand square feet of the structure.



Figure 7-16: Debris Analysis Parameters Table

The **Shelter** menu item opens the **Shelter Parameters** dialog (Figure 7-17), which has multiple tabs and provides access to the various parameters that affect the number of people who are evacuated (displaced) and the number of people who require short-term sheltering. Because the Flood Model does not address flooding, such as flash flooding or long-duration flooding, Hazus assumes that the local authorities will have time to alert the residents and evacuate directly from the areas that will flood. This means any portion of a census block that is flooded initially is assumed to have all of the residents removed from the area. Ultimately, the level of damage within the GBS and the characteristics of the population will determine how many people require short-term sheltering.

The first tab shown in Figure 7-17, **Evacuation**, allows the user to modify the **Evacuation buffer in feet**, which will have a direct impact on the results. This value is a buffer the Flood Model will add to the current floodplain polygon. In essence, this value will increase the floodplain polygon by the distance input by the user, such as 500 feet. The model will then estimate the total population within the floodplain boundary and the buffer to identify the displaced population.

Shelter Parameters	
Evacuation	
Access	
Depth in feet at which ingress/egress is restricted:	0.5
Evacuation Zone	
Evacuation buffer in feet (additional perimeter evacuated for public safety):	0
	OK Cancel

Figure 7-17: Shelter Evacuation Parameter Dialog

The **Utility Factors** tab includes a field for **Utility Outage**, which is used in the determination of the short-term shelter needs. The lack of utilities to areas impacted by floodwaters will prevent some of the displaced population from immediately returning to their homes. This percentage is used to help determine the short-term needs. This factor is not currently editable in Hazus.

Shelter Parameters		
Evacuation Utility Factors Weighting F	actors Modification Factors	
Utility Outage		
	Percent of affected households (0-100):	%
		OK Cancel

The **Weighting Factors** tab is a table where the user can modify the weighting applied to certain demographic characteristics for the population. As shown in Figure 7-19, the table includes income and age. These values should sum to 1.0.

vacua	tion <u>U</u> tility Fa	ctors (Weig	hting Factors	ion Factors		
		Class		ImportanceFact		
	1 IW		Income Weighting Fa			
	2 AW		Age Weighting Factor	0.20		

Figure 7-19: Shelter Weighting Factors Table

The **Modification Factors** tab could be considered more closely than the weighting factors sub classification weighting. For example, Figure 7-20 shows the **Age** modification factors. These factors allow the user to place more emphasis or increase the importance of a certain population (under 16 or over 65), thereby increasing the number of people in those categories who would seek shelters. The dropdown menu also provides the user with access to the **Income** weighting. Like the **Age** factor, this weighting allows the user to place more importance on those residents that fall within a certain income range. These values should be between 0.0 and 1.0.

Age	dification factors for e	•		
	Class	Description	ImportanceFact	
1	AM1	Population under 16-years old	0.05	
2	AM2	Population between 16 and 65-years old	0.20	
3	AM3	Population over 65-years old	0.50	

Figure 7-20: Shelter Modification Factors Table

Because no default value can be provided, the **Agriculture** menu item may be most important among the analysis parameters and requires user input for the agriculture analysis to run properly. Agriculture products depend on the date when the flooding occurs. For example, if the flood occurs during the winter and the type of crops grown in the region is typically planted in the spring, the net loss to the region will be small. However, if the flooding occurs just prior to harvest, when the farmers are the most heavily invested and their opportunity to replant is the smallest, then the impacts and losses will be greater.

As stated previously, the Flood Model will determine the Julian date based on the date the user inputs to the Flood Model. Figure 7-21 shows the dialog in which the user provides a calendar date for when flooding occurred. Select the day (01–31) and month (January–December) from the drop-down menus for conversion to a Julian date (1–365).

Figure 7-21: Agriculture Calendar Date Parameter Dialog

Agricultural Param	neters	×
Enter the date the	e flooding occurred:	
Day	Month	•
	OK	Cancel

The **Direct Economic** parameter menu item opens the **Direct Economic Loss Parameters** dialogs, which includes three tabs shown in Figure 7-22 through Figure 7-24. This dialog provides the user with access to the default parameters that control the estimation of the direct damages to the GBS. This includes the impact of the flood scenario on the wages, income, inventory, and maximum restoration time for the GBS. The **Business Inventory** tab defines the amount of inventory in the Study Region based on the square footage of specific census blocks.

Direct Econor	mic Loss Parameters			
usiness Inventi	ory Restoration Time Incom	- Law Data		
rusiness miverio	ory Restoration Time Incom	ie Loss Data		
	Annual Gross Sales	(\$ per sqft)	•	
Business Sal	es Amount			
Datimoto da	SpecificOccupancy	AnnualGrossSalesPerSgFt		
1	COM1	53.00		
2	COM2	77.00		
3	IND1	713.00		
4	IND2	226.00		
5	IND3	697.00		
6	IND4	656.00		
7	IND5	437.00		
8	IND6	768.00		
9	AGR1	148.00		
				i l
•				
			Class	
			Close	Print

Figure 7-22: Direct Economic Loss – Business Inventory Table

The GBS restoration functions define the maximum amount of time it should take for any given specific occupancy to be restored. For example, in Figure 7-23 the RES1 restoration time is based on the depth of flooding within the structure. In the case of RES1, even though the water has not fully entered the structure, it may take up to a year to clean up the structure, replace any sub-flooring that may be damaged, obtain permits, and perform inspections. This is a maximum timeline meant to provide a conservative estimate for the losses associated with the restoration process.

💷 D	lirect Econor	nic Loss Parameters			[- • •
Bu	siness Invento	nory Restoration Time Incor	ne Loss Data			
	Silless invento	incorrection and incorrection	ne Loss D'ala			
		BES1			_	
	Occu	pancy: RES1			•	
	T ·					
	Time					
	A	SpecificOccupancy	MinimumDepth	MaximumDepth	MaximumDaysForRestoration	100
	1	RES1 RES1	-4 0	0		180 360
	3	REST	4	8		450
	4	RES1	8	24		720
				, in the second s		
						E
						+
	•					•
					Close	Print

Figure 7-23: Direct Economic Loss –Restoration Time Table

Figure 7-24 shows some additional parameters used to develop the direct losses for wages and capital income presented in the GBS economic losses.

🛯 Direct Econo	mic Loss Parameters		
Business Invent	ory Restoration Time Incon	ne Loss Data	
	Rental		•
Rental Loss			
	SpecificOccupancy	RentalCostsPerSqFtPerMonth	RentalCostsPerSqFtPerDay 🔷
1	RES1	0.79	0.03
2	RES2	0.55	0.02
3	RES3A	0.71	0.02
4	RES3B	0.71	0.02
5	RES3C	0.71	0.02
6	RES3D	0.71	0.02
7	RES3E	0.71	0.02
8	RES3F	0.71	0.02
9	RES4	2.36	0.08
10	RES5	0.47	0.02
11	RES6	0.86	0.03
12	COM1	1.34	0.04
13	COM2	0.55	0.02
14	COM3	1.57	0.05
15	COM4	1.57	0.05
16	COM5	1.96	0.07
17	COM6	1.57	0.05
18	COM7	1.57	0.05
10	COMR	1.01	0.07
•	III		E.
			Close Print

Figure 7-24: Direct Economic Loss – Rental, Owner-Occupied, Wages and Capital, and Recapture Factors Table

7.4 Flood Warning

Flood warning is another key parameter (selected from the **Analysis / Flood Warning** menu shown in Figure 7-25) the user can use to perform "what-if" type analysis efforts. Flood warning is an interesting issue in that everyone assumes that damage and losses can be reduced with effective flood warning, but there is considerable disagreement over the amount of reduction, or even if it is possible to reduce damages based on effective warning. The Flood Model takes advantage of the famous Day curve developed by the USACE. This curve attempts to quantify the maximum level of damage reduction achievable based on the amount of time since the issuance of a flood warning. The curve itself approaches a maximum value of approximately 35 percent for structural, content, and business inventory losses regardless of how much warning is available.

Instead of having the user input a warning time and Hazus interpreting the Day curve to provide an expected reduction in damage, the Technical Manual provides the Day curve and the Flood Model asks the user to estimate the warning time, find the expected reduction in damage, and input this value in the dialog shown in Figure 7-26. The Flood Model will then uniformly reduce the damage by the anticipated reduction. In the case of vehicles, there is no guidance on how much vehicular damage can be avoided with warning. Conventional wisdom would indicate that the percentage should be relatively high. With little information to work from, the Flood Model allows the user to select vehicular reductions.



Figure 7-25: Analysis / Flood Warning Menu

Flood Warning Parameters	
Structure loss reduction Enter expected reduction in struc	ture flood loss due to flood warning (0-35%)
Content loss reduction Enter warning time (hrs) Expected loss reduction (0-35%)	Inventory Enter warning time (hrs) Expected loss reduction (0-35%)
Vehicles Expected percentage of veh	hicles to be moved from flood plain (0-100%)

Figure 7-26: Warning Parameters Dialog

Note that the parameters for structures, contents, and business inventory are limited to a maximum of 35 percent based on the maximum provided by the Day curves. The user could input 100 percent reduction for vehicular damage, and this may not be unreasonable if an area is evacuated with plenty of warning time. Note that the Flood Model provides the user the option to input the warning time to help them remember the parameters that led to the value input into the dialog.

7.5 Annualized Loss

Average Annualized Loss Menu, shown in Figure 7-27, is the calculation step where a user combines a series of individual recurrence interval losses into an additional estimate for annual loss. This analysis is performed after the user has performed a **Full Suite of Return Periods** analysis in the **Hazard** menu (as shown in Figure 7-28 and Figure 7-29 for riverine and coastal analysis) and has performed a loss analysis in the **Analysis / Run** menu.

Ana	alysis	Results	Bookmarks	Insert
	Dam	iage Funct	ions	•
	Rest	oration Fu	nctions	→
1	Para	meters		•
	Floo	d Warning		
	Aver	age Annu:	alized Loss	
	Corr	nbined Wir	nd and Flood	
	Quid	k Analysis		
	Run			

Figure 7-27: Analysis / Average Annualized Loss Menu

Figure 7-28: Riverine Flood Full Suite of Return Periods Analysis



Figure 7-29: Coastal Flood Full Suite of Return Periods Analysis

Analy	sis type: 🛛 🛛	Full Suite of Return Periods	s		-	Fill All
Jutpu	ut cell size: [26.2501639520329			•	
Coas	tal Shorelines	i				
	Shore ID	Return Periods (yrs)		^		
	া	10, 25, 50, 100, 500		=		
	1	10, 25, 50, 100, 500		-		
•		m	۲			

The user has the option of performing average annualized loss calculations for either GBS or UDF data, as shown in the **Average Annualized Loss Analysis** dialog (Figure 7-30) if loss analysis has been performed for the five required events (10-, -25-, 50-, 100-, and 500-year).

Figure 7-30: Average Annualized Loss Analysis Dialog

Average Annualized Loss (AAL) Analysis	×
Select which analysis to run:	OK
General Building Stock (GBS) direct economic loss User Defined Facilities (UDF) loss	Cancel

If the user has not performed the required loss analysis prior to trying to run the average annualized loss (AAL), Hazus will produce the error messages shown in Figure 7-31 and Figure 7-32 requesting the user to perform these prerequisite analyses.

Figure 7-31: Average Annualized Loss GBS Error Dialog



Figure 7-32: Average Annualized Loss UDF Error Dialog



7.6 Combined Wind and Flood

The **Combined Wind and Flood** menu (Figure 7-33) will become activated when a user has performed the prerequisite analysis for a storm surge analysis in both the Hurricane Model and Flood Model. See Chapter 11 for more details on all of the steps to perform this type of analysis.

Ana	lysis	Results	Bookmarks	Inse			
	Damage Functions						
	Restoration Functions						
	Parameters						
	Flood Warning						
	Average Annualized Loss						
	Com	ibined Wir	nd and Flood				
	Quic	Quick Analysis					
	Run						

Figure 7-33: Analysis / Combined Wind and Flood Menu

7.7 Quick Analysis: Quick Look and Enhanced Quick Look

Chapter 13 includes detailed step-by-step instructions on how to perform **Quick Look** and **Enhanced Quick Look** analyses.

The **Quick Look** and **Enhanced Quick Look** were created to provide the user a way of performing a very quick "snapshot" type analysis to gain some insight into a particular problem. The **Quick Analysis** is intended to be used on very localized flooding issues, and is intended to allow the user to establish some known condition and attempt to provide a quick quantification of potential loss. **Quick Look** and **Enhanced Quick Look** do not establish a flow regime.

The following is an example of how the Quick Analysis might be used:

Heavy rains fall in a community with one basin where water typically collects. Several years later, the area, which is outside of any regulatory floodplain, has been developed. In **Quick Look**, the user can quickly draw a few polygons and assign a depth of flooding to each in accordance with the recollections of the local population. In **Enhanced Quick Look**, the user can import a floodplain boundary polygon along with the DEM. The user would then perform a loss analysis to identify potential losses.

7.8 Run

Once the user parameters have been selected or modified, select **Run** from the **Analysis** menu (Figure 7-34). The Analysis Options dialog shown in Figure 7-35 will appear. Clicking on the plus and minus signs will expand and collapse the lists of available options, respectively. Click on the boxes of the desired analysis options. A check mark will appear to indicate the options have been selected. Note that some analysis options have pre-requisite analysis requirements and selection of those options will automatically check the box of the prerequisites. At the bottom of the dialog, Hazus will indicate the amount of hard drive disk space available on the machine and the percentage of the Study Region's database that has been used thus far. The

Study Region's database has a limit of 10 GB; therefore, if the percentage used is more than 50 percent, less than 5 GB of space is available for the analysis.



Figure 7-34: Analysis / Run Menu

Figure 7-35: Select Analysis Options

Analysis Options	
 Ceneral Building Stock Damage and Loss Content Damage (%) Direct Economic Loss (\$) (Bldg, Cont, Inv) Damage Building Count Depreciated Building and Content Loss (\$) Essential Facilities Wedical Care Police Stations Fire Stations Emergency Centers Schools Utility Systems Quility Systems Vehicles Debris Direct Social Loss Casuatties What-If 	Select All Deselect All
	ок
C:\has 95.92 GB free space; [MontgomeryCo_VA] is 268 MB (97.38% free)	
	Cancel
Hazus can conduct default analysis runs for the following items:

- GBS
- Essential facilities
- Selected infrastructure, including highway bridges and water systems
- Agriculture products
- Vehicles
- Debris
- Shelter requirements

The types of default data provided for the Study Region limit the type of analysis that can be run. To run a What-If analysis, the same analysis must have been run from the hazard menu. When the desired analysis options have been selected, click **OK**.

- When running the Analysis, the Hazus screen might go blank or the Task Manager Applications tab will indicate that Hazus is not responding. This is a common occurrence for any software process-heavy software. To see whether Hazus is still running, check the Task Manager Processes tab and sort the CPU column in descending order. The "sqlservr.exe" process should be on top. If the "System Idle Process" is constantly on top at 99–100%, Hazus is not responding. Also, check the Performances tab and make sure the CPU Usage is not 0 over a period of time. Another option is to open the scenario folder (in "Details" view within Windows Explorer) and make sure the FIAnalysisLog is updating by looking at the "Date modified."
- Running the Analysis, specifically the General Building Stock Damage and Loss, can take up to many hours to process and successfully complete.

For users who would like to view the intermediate analysis completion status, go to **Customize** menu and select **Flood Options** (as shown in Figure 7-36), and check the **Show redo analyses Warning message box(es)** checkbox (example shown in Figure 7-37). This option only applies if the user is redoing the analyses.

Cus	tomize	Windows	Help
	Toolba	irs	
	Extensions		
	Add-In	Manager	
	Custor	nize Mode	
	Style Manager		
	Flood	Options	
	ArcMa	p Options	

Figure 7-36: Customize / Flood Options Menu

Startup Options	Raster Options	Automation	Repository
A	lways show DEM (if available)	
A	lways show compu	uted Reaches (i	f available)
14 A.			
V V	pen last Scenario	(if available)	
🔽 S	how redo analyses	Warning mess	age box(es)
V A	utomatically remov	e problem reac	h(es)
2000) CustomBu	iffer (default: 20	00 m)
- References		90 v	200

Figure 7-37: Check Show Redo Analyses Warning Message Box(es)

8 Model Menu: Results

The **Results** menu (Figure 8-1) within Hazus has a number of analysis types and menus from which to choose. These options enable the user to select the appropriate results to review in the Study Region. This section explains each selection and menu to further the user's understanding of these options. The analyses associated with **Advanced Building Analysis** and **Indirect Economic Analysis** is inactive in the Flood Model.

Resu	ults	Bookmarks	Insert	Selection	6		
	Vie	w Current Scer	nario Res	ults By			
	Flo	od Hazard Map	o s		۲		
	General Building Stock						
	Combined Wind and Flood Loss						
	Ess	ential Facilities					
	Use	r Defined Facil	lities				
	Adv	vanced Buildin	g Analys	is			
	Tra	nsportation Sy	stems				
	Util	ity Systems					
	Agricultural Products						
	Veł	nicles					
	Deł	oris					
	Cas	alties			×		
	She	lter					
	Ind	irect Economic	: Loss				
Essential Facilities User Defined Facilities Advanced Building Analysis Transportation Systems Utility Systems							
	Sur	nmary Reports					

Figure 8-1: Results Menu

8.1 View Current Scenario Results By

Once the loss analysis has been run, the next step is to view the results. The first option within the **Results** menu (Figure 8-2) is **View Current Scenario Results By...** Selecting this option activates the **View Results by** window shown in Figure 8-3. Select one of the **Available Results**. No results can be viewed until a hazard analysis has been selected.

sults	Bookmarks	Insert	Selection	6			
Vie	w Current Scer	nario Res	ults By				
Flo	od Hazard Maj	os		F			
Gei	neral Building	Stock		Þ			
Co	Combined Wind and Flood Loss						
Ess	ential Facilities						
Use	er Defined Faci	ities					
Ad	vanced Buildin	g Analys	is				
Tra	nsportation Sy	stems					
Uti	Utility Systems						
Ag	ricultural Prod	ucts					
Vel	nicles						
Del	bris						
Ca	sualties			F			
She	elter						
Ind	irect Economi	: Loss					
Qu	ick Analysis Re	port					
Sur	mmary Reports						

Figure 8-2: Results / View Current Scenario Results By Menu

Figure 8-3: Select Available Results

View Results by
Scenario Name:
test
Scenario Description:
testing123
Available Results:
100 •
Include Flood Warning Parameters
OK Cancel

8.2 Flood Hazard Map

To map the flood depth grid and floodplain boundary for the current scenario and return period/discharge(s), select **Thematic Map of Depth** from the **Results / Flood Hazard Maps** menu. The flood depth grid will be displayed in blue. The floodplain boundary will be displayed in orange in the main Flood Model map window.

The three options on the **Results / Flood Hazard Maps** menu (Figure 8-4), **By Census Block**, **Thematic Map of Depth**, and **Thematic Map of Agriculture Products**, will add specific symbolized layers to the map. These options can be used as visualization tools to understand specific spatial patterns in the Study Region.

Hazus automatically maps the flood depth grid and floodplain boundary for one of the available depth grids when the hazard is computed, but other flood depth grids are available to be mapped that may have also been computed.

Resu	ults Bookmarks Insert Selection	Geoprocessing Customize Windows Help
	View Current Scenario Results By	s 🗁 🚽
	Flood Hazard Maps	By Census Block
	General Building Stock	Thematic Map of Depth
	Combined Wind and Flood Loss	Thematic Map of Agriculture Products
	Essential Facilities	
	User Defined Facilities	
	Advanced Building Analysis	
	Transportation Systems	
	Utility Systems	
	Agricultural Products	
	Vehicles	
	Debris	
	Casualties •	
	Shelter	
	Indirect Economic Loss	
	Quick Analysis Report	
	Summary Reports	

Figure 8-4: Results / Flood Hazard Maps Menu

8.3 General Building Stock Damage

To view and map the general inventory damage results By Occupancy, By Building Type, and By Count, select **General Building Stock** from the **Results** menu (Figure 8-5).

Results Bookmarks Insert Selection	Geoprocessing Customize
View Current Scenario Results By	5 🖸 📴 🖕
Flood Hazard Maps	
General Building Stock	By Occupancy
Combined Wind and Flood Loss	By Building Type
Essential Facilities	By Count
User Defined Facilities	Economic Loss 🔸
Advanced Building Analysis	
Transportation Systems	
Utility Systems	
Agricultural Products	
Vehicles	
Debris	
Casualties •	
Shelter	
Indirect Economic Loss	
Quick Analysis Report	
Summary Reports	

Figure 8-5: Results / General Building Stock Menu

8.3.1 General Building Stock Damage by Occupancy

Select **By Occupancy** from the **Results** / **General Building Stock** menu (Figure 8-5) to view and map tabular damage results by census block. The user can show values based on **General Occupancy Type** or **Specific Occupancy Type** and choose between **Pre-Firm**, **Post-Firm**, or **All** (Figure 8-6). Select a specific column with numeric values in the table and click the **Map** button to map the tabular results. Mapped results will appear on the screen.

💷 General Bui	ilding Stock Damage	By Occupancy			
Results for Scenario: test	t			Return	period: 100
General Occ	upancy Type 🛛 👻	Residential	▼ Pre-Firm	•	
	CensusBlock	TotalSquareFootage	SgFtWithSubstantialDmg	UndamagedSgFt	SqFtE 🔺
1	240399301011195	0.15	0.00	0.07	
2	240399301011199	0.00	0.00	0.00	=
3	240399301011200	0.00	0.00	0.00	
4	240399301011201	0.00	0.00	0.00	
5	240399301011202	0.00	0.00	0.00	
6	240399301011203	0.00	0.00	0.00	
7	240399301011208	0.00	0.00	0.00	
8	240399301011210	0.00	0.00	0.00	
9	240399301011211	0.00	0.00	0.00	
10	240399301011212	0.00	0.00	0.00	
11	240399301011221	0.00	0.00	0.00	
12	240399301011222	0.06	0.00	0.04	
13	240399301011223	0.03	0.00	0.01	
14	240399301021190	0.38	0.00	0.11	
15	240399301021259	0.00	0.00	0.00	
16	240399303003012	0.23	0.00	0.14	
17	240399303003030	0.28	0.00	0.18	
18	240399303003031	0.00	0.00	0.00	+
•	111				F.
			Close	Map	Print

Figure 8-6: General Building Stock Damage Results Table

8.3.2 General Building Stock Damage by Building Type

Select **By Type** from the Results / **General Building Stock** menu (Figure 8-5) to view and map tabular damage results for wood, steel, concrete, masonry, and manufactured housing types. Select the desired type of structure from the dropdown menu (Figure 8-7).

	s for irio: AAL			Return period:	10
Wood		Total			
		TOTAL	*		
Wood Steel					
Concr					
Masor Manul	nry fHousing	TotalSquareFootage	SqFtWithSubstantialDmg	UndamagedSqFt SqFt	C A
	1 400272014031000	0.00	0.00	0.00	
	2 400272014031001	0.00	0.00	0.00	1
	3 400272014031002	0.00	0.00	0.00	-
	4 400272014031003	0.00	0.00	0.00	-
	5 400272014031004	0.00	0.00	0.00	-
	6 400272014031006	14.00	0.00	3.00	-
	7 400272014032000	0.00	0.00	0.00	-
	8 400272014032001	0.00	0.00	0.00	-
	9 400272014032002	4.00	0.00	0.00	-
1	0 400272014033000	0.00	0.00	0.00	
1	11 400272014033001	0.00	0.00	0.00	
1	12 400272014033002	0.00	0.00	0.00	
1	3 400272014033003	0.00	0.00	0.00	
1	4 400272014033004	0.00	0.00	0.00	
1	15 400272014033005	0.00	0.00	0.00	
1	I6 400272014033006	0.00	0.00	0.00	
1	17 400272014033007	0.00	0.00	0.00	
1	8 400272014033014	0.00	0.00	0.00	Ŧ
4				4	

Figure 8-7: Building Stock Damage by Building Type Table

8.3.3 General Building Stock Damage Count

Select **By Count** from the **Results / General Building Stock** menu (Figure 8-5) to view and map the tabular damage results. For **County By Occupancy**, the user can choose counts based on **General Occupancy Type** or **Specific Occupancy Type** and choose between **Pre-Firm**, **Post-Firm**, or **All** (Figure 8-8). Use the dropdown menus to select which data to view.

Count By Occupancy	k Damage Count ount By Type	-			
Results for Scenario: AAL				Return pe	eriod: 100
General Occupancy 1	ſype ▼ Residen	tial 👻	Pre-Firm	•	
	n <mark>susBlock </mark> TotalB		vithSubstantialDmg	UndamagedBldgs	PetDr 🔺
	014031000	0	0	0	
	014031001	0	0	0	
	014031002	0	0	0	
	014031003	0	0	0	
	014031004	0	0	0	
	014031006	1	0	0	
	014032000	0	0	0	
	014032001	0	0	0	
9 400272	014032002	0	0	0	
	014033000	0	0	0	
11 400272	014033001	0	0	0	
11 400272 12 400272	014033002	0	0	0	
11 400272 12 400272 13 400272	014033002 014033003	0	0	0	
11 400272 12 400272 13 400272 14 400272	014033002 014033003 014033004	0 0 0	0 0 0	0 0 0	
11 400272 12 400272 13 400272 14 400272	014033002 014033003	0	0	0	

Figure 8-8: General Building Stock Damage Count Table

8.3.4 General Building Stock Direct Economic Losses

The Economic Loss option on the Results / General Building Stock menu allows the user to view and map economic losses for the GBS by census block by full replacement value and depreciated replacement value. Direct economic losses can be displayed By General Occupancy, By Specific Occupancy, By General Building Type, and Total as shown in Figure 8-9. Use the dropdown menus to select which data to view.

Figure 8-9: General Building Stock Direct Economic Losses for Full Replacement Value (By General Occupancy) Table

By General	Occu	pancy By Specific O	ccupancy By G	eneral Building Type	e Total		
Results	for						
Scenari	io: AAl	-				Re	eturn period: 100
Reside		_	Pre-Firm	•			
Reside Comme							
Industr							
Agricul		n Drafit	Taballana	Duditional and	Contractal and	I	Deless for C
Govern		n-Profit	TotalLoss 3	BuildingLoss 2	ContentsLoss	InventoryLoss 0	RelocationC 🔺
Educa		400212014001001	18	12	6	0	
3		400272014031002	0	0	0	0	
4		400272014031003	32	21	11	0	
5		400272014031004	18	12	6	0	
6		400272014031006	323	207	116	0	
7		400272014032000	0	0	0	0	
8		400272014032001	0	0	0	0	
9		400272014032002	268	172	96	0	
10)	400272014033000	0	0	0	0	
1	1	400272014033001	8	5	3	0	
12	2	400272014033002	0	0	0	0	
10	3	400272014033003	0	0	0	0	
14		400272014033004	1	1	0	0	
15	5	400272014033005	0	0	0	0	
•							F

8.3.5 Viewing and Exporting Data from Building Stock Damage Menus

To view the damage results spatially, click on one of the columns with loss values, such as the **TotalLoss** field (Figure 8-10) on the desired tab of the Direct Economic Losses table and click the **Map** button at the bottom right hand corner. The data will appear a new data layer within the Hazus project and ESRI shapefile format. Once the data are listed in the Flood Map Table of Contents, right click on the data layer and export the data to a shapefile, which can be imported into database and spreadsheet programs for further analysis.

To view the damage results only in a tabular format, right click within the table and select **Export** (Figure 8-11).

Figure 8-10: General Building Stock Direct Economic Losses for Full Replacement Value (Total) Results

Direct Economic Losses For Full Replacement Value							
				e Total			
By General Occ	upancy By Specific O	ccupancy By U	General Building Typ				
Results for							
Scenario: 10)0-yr				R	eturn period: 100	
Total	-						
Total							
	CensusBlock	TotalLoss	BuildingLoss	ContentsLoss	InventoryLoss	RelocationC 🔺	
1	511210203001029	17	12	3	0		
2	511210203002001	377	198	118	0		
3	511210203002005	74	47	20	0		
4	511210203002009	20	14	6	0		
5	511210203002011	204	121	53	0		
6	511210203002012	37	26	11	0		
7	511210203002013	248	115	79	1		
8	511210203002014	50	30	13	0		
9	511210203002015	54	34	17	0		
10	511210203002017	890	348	298	5		
11	511210203002032	76	21	25	0		
12	511210203002036	638	77	179	0		
13	511210203002037	31	19	8	0		
14	511210203002042	0	0	0	0		
15	511210203002043	0	0	0	0	+	
•		I				E.	
				[(Close Map	Print	
						43	

Figure 8-11: Export General Building Stock Direct Economic Losses for Full Replacement Value (By Occupancy) Results

General Oc Results for	cupancy By Specific O	ccupancy By Ge	neral Building Type	e lotal		
Scenario: A	AL				R	eturn period: 100
Residentia	•	Pre-Firm	•			
	ConsusPlask	Totall and	PyildingLoss	ContentsLoss	InventoryLoss	RelocationC
1	Add New Reco	ord	2	1	0	
2	Delete Selecter	d Records	12	6	0	
3				0	0	
4	Import		21	11	0	
5			12	6	0	
6	Export		207	116	0	
7	Data Dictionar		0	0	0	
8		У	0	0	0	
9	Meta Data		172	96	0	
10	400272014033000	0	0	0	0	
11	400272014033001	8	5	3	0	
12	400272014033002	0	0	0	0	
13	400272014033003	0	0	0	0	
14	400272014033004	1	1	0	0	
15	400272014033005	0	0	0	0	
						F

8.4 Combined Wind and Flood Loss

When a storm surge analysis has been performed (see Chapter 11 for all steps in that type of analysis), the user can show results from the combined wind flood loss analysis with the **Combined Wind and Flood Loss** menu (Figure 8-12). Selecting that menu will bring up the window shown in Figure 8-13, which includes some of the fields that Hazus calculated when a combined hurricane wind and flood surge analysis was conducted, where results are shown for each hazard type individually and the weighted combination. The combined losses are weighted based on how each hazard type contributes to overall damages, with flood hazards typically damaging the lower portions of a structure (foundation, lower floors) and hurricane wind hazards typically damaging upper portions of a structure (roof, upper floors). Refer to the Hazus Flood and Hurricane Technical Manuals for more details on how the combined results are calculated.

Result	ts Bookmarks Insert Selection						
1	/iew Current Scenario Results By						
F	Flood Hazard Maps						
C	General Building Stock						
(Combined Wind and Flood Loss						
E	Essential Facilities						
ι	Jser Defined Facilities						
1	Advanced Building Analysis						
	Fransportation Systems						
l	Jtility Systems						
ļ	Agricultural Products						
١	/ehicles						
[Debris						
Ċ	Casualties 🔹 🕨						
5	Shelter						
Ι	ndirect Economic Loss						
0	Quick Analysis Report						
\$	Summary Reports						

Figure 8-12: Results / Combined Wind and Flood Loss Menu

Figure 8-13: Combined FL/HU Surge Direct Economic Losses for Full Replacement Value (By General Occupancy) Table

Results for								
Scenario: Brunswick Return period: Mix0								
Residential	•	Pre-Firm	•					
	CensusBlock	BidgFloodLoss	BldgWindLoss	BidgCombLoss	ContFloodLoss	ContW		
1	370190201011003	0.00	0.05	0.05	0.00			
2	370190201011005	0.00	0.04	0.04	0.00			
3	370190201011006	0.00	0.05	0.05	0.00			
4	370190201011007	0.00	0.07	0.07	0.00			
5	370190201011009	0.00	0.05	0.05	0.00			
6	370190201011011	0.00	0.07	0.07	0.00			
7	370190201011014	0.00	0.23	0.23	0.00			
8	370190201011017	0.00	0.05	0.05	0.00			
9	370190201011018	0.00	0.30	0.30	0.00			
10	370190201011019	0.00	0.04	0.04	0.00			
11	370190201011020	0.00	0.94	0.94	0.00			
12	370190201011021	0.00	0.12	0.12	0.00			
13	370190201011024	0.00	0.92	0.92	0.00			
14	370190201011027	0.00	0.09	0.09	0.00			
15	370190201011029	0.00	0.09	0.09	0.00			
						E.		

8.5 Essential Facilities

Essential Facilities results, selected in Figure 8-14 and shown in Figure 8-15, allow the user to view and map losses and damages to Essential Facilities, including **Medical Care Facilities**, **Emergency Centers**, and **Schools**. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

0-14:	Results / Essential Facili
Γ	Results Bookmarks Insert Selection G
-	View Current Scenario Results By
	Flood Hazard Maps
-	General Building Stock
	Combined Wind and Flood Loss
	Essential Facilities
	User Defined Facilities
	Advanced Building Analysis
	Transportation Systems
	Utility Systems
	Agricultural Products
	Vehicles
	Debris
	Casualties +
	Shelter
	Indirect Economic Loss
	Quick Analysis Report
	Summary Reports



Figure 8-15: Essential Facilities (Schools) Table

🛯 Essential Facil	lities				
Medical Care Fa	cilities Emergency	Centers Schools			
Results for Scenario: 10	D-yr				Return period: 100
	Schoolld	Name	ControllingHazard	EfClass	Description 🔺
1	VA002146	SHAWSVILLE ELEM R		EFS1	Grade Schools (Prima
					E
•		III			۲.
				Close	Map Print

8.6 User-Defined Facilities

User-Defined Facilities results, selected in Figure 8-16 and shown in Figure 8-17, allow the user to view and map losses and damages to individual UDFs. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

Result	s Bookmarks	Insert	Selection				
١	View Current Scenario Results By						
F	lood Hazard Ma	ps		Þ			
0	General Building Stock						
(ombined Wind	and Floo	d Loss				
E	ssential Facilitie	s					
l	lser Defined Fac	ilities					
1	dvanced Buildir	ng Analys	is				
	Transportation Systems						
l	Itility Systems						
/	gricultural Prod	ucts					
١	ehicles						
[ebris						
0	asualties			Þ			
\$	helter						
Ι	ndirect Economi	c Loss					
(uick Analysis R	eport					
	ummary Report	s					

Figure 8-16: Results / User-Defined Facilities Menu



icenario: 10						Return p	period: 1
	BldgCost	ContentCost	BldgDmgPct	ContDmgPct	BidgLossUSD	ContentLossUSD	Inv -
45	\$210,324,99	\$105,162.00	43.00	52.63	90,439.75	55,346.60	ILLA .
46	\$152,945.39	\$76,473.00	24.50	33.33	37,468.73	25,486.18	
40	\$195,957.09	\$97,979.00	28.15	36.15	55,156.83	35,416.86	
48	\$212,656,25	\$106,328.00	46.94	60.00	99,818.32	63,796,80	
49	\$214,631,31	\$107,316.00	45.05	60.00	96,696,49	64,389.60	
50	\$214,908.77	\$107,454.00	46.94	60.00	100,876,67	64,472,40	
51	\$216,630.41	\$108,315.00	40.54	45.90	87,824.10	49,718.36	
52	\$216,907.38	\$108,454.00	24.23	32.44	52,558.14	35,177.72	
53	\$218,127.32	\$109,064.00	18.79	14.57	40,987.00	15,889.33	
54	\$218,138.92	\$109,069.00	43.00	53.60	93,799,74	58,459.83	
55	\$222,649.79	\$111,325.00	28.36	36.36	63,148,88	40,480.47	
56	\$223,870.45	\$111,935.00	43.00	52.29	96,264.29	58,534.27	
57	\$224,075.16	\$112,038.00	23.58	30.27	52,838.40	33,912.63	
58	\$225,376.52	\$112,688.00	30.38	39.14	68,467.75	44,103.62	:
59	\$225,966.76	\$112,983.00	35.65	43.07	80,550.85	48,656.61	
60	\$136,960.68	\$68,480.00	11.23	8.70	15,387.01	5,960.40	
61	\$198,410.67	\$99,205.00	11.77	10.31	23,356.06	10,232.73	
62	\$226,528.95	\$113,264.00	43.00	52.28	97,407.45	59,215.94	
63	\$258,209.85	\$129,105.00	43.00	51.48	111,030.24	66,469.30	
64	\$111,493.48	\$55,747.00	19.21	15.92	21,413.77	8,875.19	
65	\$116,481.16	\$58,241.00	20.86	21.31	24,302.36	12,409.55	
66	\$146,869.96	\$73,435.00	20.50	20.14	30,114.08	14,788.12	
4	#041.0E0.40	#100.070.00	nt_col	07 CC	ED 000 01	20 701 12	F.

8.7 Transportation Systems

Transportation Systems results, selected in Figure 8-18 and shown in Figure 8-19, allow the user to view and map losses and damages to transportation systems, including **Highway**, **Railway**, **Light Rail**, **Bus**, **Port**, **Ferry**, and **Airport**. However, losses from flood will only be calculated for bridges and only as they relate to scour. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.



Figure 8-18: Results / Transportation Systems Menu

Figure 8-19: Transportation Systems Damage/Economic Loss (Highway) Table

Results for Scenario: 50	00				Return pe	riod: 10
Highway Br	idaes 👻					
	-gro					
	HighwayBridgeld	BridgeName	BridgeClass	Description	DamagePct	Lossi
6	VA007212	NBL ROUTE 0081	HWB12	Steel, Multi-Column B	0.31	
7	VA007213	SBL ROUTE 0081	HWB12	Steel, Multi-Column B	0.31	
8	VA007239	NORTH FORK RD.	HWB3	Single Span (Not HV	1.25	
9	VA007240	NORTH FORK RD.	HWB12	Steel, Multi-Column Br	0.31	
10	VA007246	NORTH FORK RD.	HWB15	Continuous Steel (Cor	0.31	
11	VA007266	BRADSHAW RD.	HWB3	Single Span (Not HV	1.25	
12	VA007267	BRADSHAW RD.	HWB26	Same definition as HV	0.31	
13	VA007268	BRAKE RD.	HWB3	Single Span (Not HV	1.25	
14	VA007271	SENECA HOLLOW P	HWB15	Continuous Steel (Cor	0.31	
15	VA007273	SENECA HOLLOW F	HWB3	Single Span (Not HV	1.25	
16	VA007312	COLES RD.	HWB28	All other bridges that a	0.31	
17	VA007313	BIG SPRING DR.	HWB5	Concrete, Multi-Colum	0.31	
18	VA007316	CANNERY RD.	HWB3	Single Span (Not HV	1.25	
19	VA007324	STONE KEEP LN.	HWB28	All other bridges that a	0.31	
	VA008824	W. MAIN ST./RT460	HWB12	Steel, Multi-Column Br	0.31	
20	VA000024					
16 17	VA007312 VA007313	COLES RD. BIG SPRING DR.	HWB28 HWB5	All other bridges that a Concrete, Multi-Colum	0.31 0.31	
19	VA007324	STONE KEEP LN.	HWB28	All other bridges that a	0.31	
20			1111012	order, matheolumnini	0.01	

8.8 Utility Systems

Utility Systems results, selected in Figure 8-20 and shown in Figure 8-21, allow the user to view and map losses and damages to utility systems, including **Potable Water**, **Waste Water**, **Oil**, **Natural Gas**, **Electric Power**, and **Communications**. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

Resi	ults Bookmarks Insert Selection	(
	View Current Scenario Results By					
	Flood Hazard Maps	۲				
	General Building Stock	•				
	Combined Wind and Flood Loss					
	Essential Facilities					
	User Defined Facilities					
	Advanced Building Analysis					
	Transportation Systems					
	Utility Systems					
	Agricultural Products					
	Vehicles					
	Debris					
	Casualties	►				
	Shelter					
	Indirect Economic Loss					
	Quick Analysis Report					
	Summary Reports					

Figure 8-20: Results / Utility Systems Menu

Figure 8-21: Utility Systems Damage/Economic Loss (Potable Water) Table

🔝 Utility Systems Damage/Economic Loss				
Potable Water Waste Water Oil Natur	al Gas Electric Powe	r Communications		
Results for	al das Eleculo Powe	Communications		
Scenario: 100-yr				Return period: 100
Table Type: Potable Water Syste	em Facilities		▼	
	Name	UtilFcltyClass	Description	DamagePct 🔺
1 VA000013	BLACKSBURG-CHR		Default Facility	40.00
				E
				-
•	m			
L				
				Map Print

8.9 Agricultural Products

Agricultural Products results, selected in Figure 8-22 and shown in Figure 8-23, allow the user to view and map losses and damages to various crops by county. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

Result	s Bookmarks	Insert	Selection	6				
٧	iew Current Scer	nario Res	ults By					
F	Flood Hazard Maps							
6	General Building Stock							
C	Combined Wind and Flood Loss							
E	Essential Facilities							
L	ser Defined Facil	lities						
A	dvanced Buildin	g Analys	is					
Т	ransportation Sy	stems						
L	tility Systems							
A	gricultural Produ	ucts						
V	ehicles							
C	ebris							
C	asualties			Þ				
S	helter							
I	ndirect Economic	Loss						
C	uick Analysis Re	port						
S	ummary Reports							

Figure 8-22: Results / Agricultural Products Menu

Figure 8-23: Agricultural Loss Table

🖳 Agricultura	al Loss						
Results for							
Scenario: tes	st					Return per	iod: 100
County		, MD (24039) 🛛 👻					
🔘 SubCoun	ty.						
	CountyFIPS	CropType	DamagePct0	DamageYield0	LossO	DamagePct3	D. 🔺
1	24039	CORN	0.00	0	0.00	0.00	
2	24039	CORN SILAGE	0.00	0	0.00	5.25	- 11
3	24039 24039	SOYBEANS WHEAT	0.00	0	0.00	0.00	- 11
							E
•							F F
						Close	Print

8.10 Vehicles

Vehicles results, selected in Figure 8-24 and shown in Figure 8-25, allow the user to view and map losses and damages to vehicles by census block and for either night or day times. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

Results	Bookmarks	Insert	Selection	G
Vie	w Current Scer	nario Res	ults By	
Flo	od Hazard Maj	ps		۲
Ge	neral Building :	Stock		۰
Co	mbined Wind :	and Floo	d Loss	
Ess	ential Facilities			
Use	er Defined Faci	lities		
Ad	vanced Buildin	g Analys	is	
Tra	insportation Sy	stems		
Uti	lity Systems			
Ag	ricultural Prod	ucts		
Vel	nicles			
De	bris			
Ca	sualties			۲I
Sh	elter			
Ind	lirect Economi	c Loss		
Qu	ick Analysis Re	port		
Sui	mmary Reports			1

Figure 8-24: Results / Vehicles Menu

Figure 8-25: Vehicle Damage and Loss (Damage) Table

Results for Scenario: te	əst			Return period:	100
Day	•				
	CensusBlock	VehicleType	TotalDamagedVehicles	TotalUndamagedVehicles	-
1	240399301011195	Car	0	0	
2	240399301011195	LtTrk	0	0	
3	240399301011200	Car LtTrk	0	0	
4	240399301011200 240399301011211	Car	0	0	
5		Lar LtTrk	0	0	
6	240399301011211 240399301011222		0	0 0	
	240399301011222	Car LtTrk	0	U	_
8	240399301011222	Car	0	U	
10	240399301011223	LtTrk	0		_
11	240399301021190	Car	0		-
12	240399301021190	HvTrk	0	0	
	240399301021190	LtTrk	0	0	-
	240399303003012	Car	0	0	-
13		Car	_		-
13 14 15	240399303003012	HvTrk	0	0	1

8.11 Debris

Debris results, selected in Figure 8-26 and shown in Figure 8-27, allow the user to view and map finish, structural, and foundation building debris results by census block. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

Results	Bookmarks	Insert	Selection	G
Vie	w Current Scer	nario Res	ults By	
Flo	od Hazard Maj	os		۲
Ger	neral Building S	Stock		۶ľ
Co	mbined Wind a	and Floo	d Loss	
Ess	ential Facilities			
Use	r Defined Faci	lities		
Adv	vanced Buildin	g Analys	is	
Tra	nsportation Sy	stems		
Uti	lity Systems			
Ag	ricultural Prod	ucts		
Veł	nicles			
Del	oris			
Cas	alties			۲
She	lter			
Ind	irect Economi	: Loss		
Qu	ick Analysis Re	port		
Sur	nmary Reports			

Figure 8-26: Results / Debris Menu

Figure 8-27: Debris Generation Table

enario: 1	00-yr					Return period: `
		T . IT		0 T	- 10 - F	
1	CensusBlock 511210203001029	TotalTons 3.32	FinishTons 1.74	StructureTons 0.51	FoundationTons 1.06	
2	511210203001023	18.39	11.00	4.53	2.86	
3	511210203002005	3.27	2.99	0.17	0.11	
4	511210203002009	0.00	0.00	0.00	0.00	
5	511210203002011	21.25	7.03	7.89	6.33	
6	511210203002012	0.00	0.00	0.00	0.00	
7	511210203002013	22.76	4.78	9.28	8.69	
8	511210203002014	0.00	0.00	0.00	0.00	
9	511210203002015	4.98	1.41	1.88	1.68	
10	511210203002017	34.55	18.56	9.15	6.85	
11	511210203002032	2.16	1.76	0.25	0.16	
12	511210203002036	0.00	0.00	0.00	0.00	
13	511210203002037	0.00	0.00	0.00	0.00	
14	511210203002042	0.00	0.00	0.00	0.00	
15	511210203002046	0.00	0.00	0.00	0.00	
16	511210205004007	0.20	0.20	0.00	0.00	
17	511210206001032	2.64	0.82	0.82	0.99	
18	511210207004000	0.16	0.09	0.04	0.03	
19	511210208004000	2.11	0.85	0.55	0.71	
20	511210208004010	0.00	0.00	0.00	0.00	
21	511210208004014	0.00	0.00	0.00	0.00	
22	511210209002001	11.99	2.85	4.60	4.54	
- 22	E1101000000000	0.50	0.71	1.00	1 50	Þ

8.12 Casualties

The **Casualties** menu (Figure 8-28) allows the user to view result **By General Occupancy**. Select **By General Occupancy** to open a report in the default word processing program (Figure 8-29).

Results	Bookmarks	Insert	Selection	Geopr	ocessing	Customize	Wind
Vie	w Current Scer	nario Res	ults By	si 🖻	- 🌬		
Flo	od Hazard Map	os		F	_		
Gei	neral Building S	Stock		•			
Co	mbined Wind a	and Floo	d Loss				
Ess	ential Facilities						
Use	er Defined Facil	lities					
Ad	vanced Buildin	g Analys	is				
Tra	nsportation Sy	stems					
Uti	lity Systems						
Ag	ricultural Produ	ucts					
Vel	nicles						
Del	bris						
Ca	sualties			•	By Gene	ral Occupancy	
She	elter						
Ind	irect Economic	: Loss					
Qu	ick Analysis Re	port					
Sur	mmary Reports						

Figure 8-28: Results / Casualties Menu

Figure 8-29: Casualties By General Occupancy Report

When the flood model was originally developed, an effort was made to develop methodology to estimate casualties due to flooding. Because there is limited data related to casualties beyond fatalities (i.e. injuries requiring hospitalization, minor injuries), the Flood Model Oversight Committee and FEMA decided to defer the estimation of casualties while further data collection and methodology development could continue. Below are two charts that can help the user assesses the likelihood of incurring casualties during a given flood event. It should be noted that the United States averages approximately 100 deaths per year due to flooding, although this has been increasing over the last few years. Figures 1 and 2 show US fatalities due to flooding, with an increasing trend which however, if normalized for population growth, appears to be relatively steady (FEMA, 1997).



8.13 Shelter

Shelter results, selected in Figure 8-30 and shown in Figure 8-31, allow the user to view and map the estimated displaced population and the short-term shelter needs by census block. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

Results	Bookmarks	Insert	Selection	G			
Vie	w Current Scer	nario Res	ults By				
Flo	od Hazard Maj	DS		F			
Gei	neral Building S	Stock		۲			
Co	Combined Wind and Flood Loss						
Ess	ential Facilities						
Use	er Defined Facil	ities					
Ad	vanced Buildin	g Analys	is				
Tra	nsportation Sy	stems					
Uti	lity Systems						
Ag	Agricultural Products						
Vel	Vehicles						
De	bris						
Ca	sualties			۲			
She	elter						
Ind	lirect Economic	: Loss					
Qu	ick Analysis Re	port					
Sur	mmary Reports						

Figure 8-30: Results / Shelter Menu

Figure 8-31: Shelter Table

	est			Return period:
	CensusBlock	DisplacedPopulation	ShortTermNeeds	
1	240399301011195	1.00	0.00	
2	240399301011199	0.00	0.00	
3	240399301011200	0.00	0.00	
4	240399301011201	0.00	0.00	
5	240399301011202	0.00	0.00	
6	240399301011203	0.00	0.00	
7	240399301011207	0.00	0.00	
8	240399301011208	0.00	0.00	
9	240399301011210	0.00	0.00	
10	240399301011211	0.00	0.00	
11	240399301011212	0.00	0.00	
12	240399301011213	0.00	0.00	
13	240399301011221	0.00	0.00	
14	240399301011222	1.00	0.00	
15	240399301011223	0.00	0.00	
16	240399301011226	0.00	0.00	
17	240399301021190	1.00	0.00	
18	240399301021259	0.00	0.00	
19	240399303003012	0.00	0.00	
20	240399303003030	1.00	0.00	
21	240399303003031	0.00	0.00	
22	240399303003035	0.00	0.00	
	24020020202020	1.00	0.00	

8.14 Indirect Economic Loss

The **Indirect Economic Loss Results** window is inactive in Hazus and will not produce any results.

8.15 Quick Analysis Report

Chapter 13 has step-by-step instructions on how to perform **Quick Look** and **Enhanced Quick Look** analyses.

After running the loss analysis for **Quick Look** or **Enhanced Quick Look**, the user will be able to review the loss results by generating a special report exclusively for the Quick Analysis. This report is created by selecting **Quick Analysis Report** from the **Results** menu (Figure 8-32). This report provides the only way to access the loss results for a **Quick Analysis**.

Results	Bookmarks	Insert	Selection	G
Vie	w Current Scer	nario Res	ults By	
Flo	od Hazard Ma	ps		۶
Ge	neral Building	Stock		۰
Co	mbined Wind	and Floo	d Loss	
Ess	ential Facilities			
Usi	er Defined Faci	lities		
Ad	vanced Buildin	ig Analys	is	
Tra	insportation Sy	/stems		_
Uti	lity Systems			
Ag	ricultural Prod	ucts		ſ
Vel	hicles			1
De	bris			ſ
Ca	sualties			F
She	elter			
Ind	lirect Economi	c Loss		f
Qu	ick Analysis Re	port		9
Sui	mmary Reports	5		

Figure 8-32: Quick Analysis Report Menu

The **Quick Look Summary Report** (Figure 8-33) consists of a two-page report summarizing the GBS results.



Figure 8-33: Quick Analysis Report

8.16 Summary Reports

The **Summary Reports** results, selected in Figure 8-34 and shown in Figure 8-35, allow the user to view and print a wide variety of reports on topics, including **Inventory**, **Buildings**, **Lifelines**, and **Losses**. The reports are created using the Crystal Reports engine that is included as part of Hazus installation. Figure 8-36 and Figure 8-37 show examples of the many reports available, as listed in Table 8-1. Figure 8-37 shows the report-viewing window in Hazus, which contains icons along the top to export or print reports and navigate through report pages. For example, the left-most icon (as shown in Figure 8-36) allows the user to export a report in pdf format. Figure 8-38 shows the export window for the user to select the report export format and file location.

Figure 8-34: Results / Summary Reports Menu

Results	Bookmarks	Insert	Selection	G
Vie	w Current Scer	nario Res	ults By	
Flo	od Hazard Map	DS .		۲I
Ge	neral Building S	Stock		۲Ì
Co	mbined Wind a	and Floor	d Loss	
Ess	ential Facilities			
Us	er Defined Facil	ities		
Ad	vanced Buildin	g Analys	is	
Tra	ansportation Sy	stems		
Uti	lity Systems			
Ag	ricultural Produ	ucts		
Vel	hicles			
De	bris			
Ca	sualties			۲
Sh	elter			
Inc	lirect Economia	: Loss		
Qu	iick Analysis Re	port		
Sui	mmary Reports			

Summary Reports	
Inventory Buildings Lifelines Induced Losses Other	
Inventory Buildings Lifelines Induced Losses Other Please select the summary report[s] to view: Agriculture Products Dollar Exposure Building Stock Dollar Exposure By Building Type Building Stock Dollar Exposure By Occupancy Transportation Systems Dollar Exposure Utility System Dollar Exposure Vehicle Dollar Exposure (Day) Vehicle Dollar Exposure (Night)	
<u>V</u> iew Close	

Figure 8-35: Summary Reports (Inventory) Window

ducts Dollar Exposure		
< → H 1/1	👿 💁 船 77% 🛛 🗸	
t		
EARTHQUAKE - WIND - PLOOD TSUNAMI		🛞 FEMA
Agriculture Products Dollar Ex	xposure	RiskMAP Increasing Resilience Together
June 20, 2018		
	Average Total Yield	Units
Virginia Montgomery		
CORN	21,778,151.4E	BU
CORN SILAGE	160,042,190.11	Тон
G RASS-LEG U ME HAY	14,024,972.58	Тов
KENTUC KY BLUEG RASS	0.00	AUM
TALL FESCUE	0.00	AUM
Total	195,845,314.05	
Total	195,845,314.05	
Study Region Total	195,845,314.05	
Totals only reflect data for those census tract		
county/state only if all of the census blocks & Study Region: No MA Scenario: test		
county/state only if all of the census blocks & Study Region: No MA		time of study region creation .

Figure 8-36: Example – Agriculture Products Dollar Exposure Summary Report

I /3	🗙 🧐 🕅 100% 🔻							
						-		
EARTHQUAKE - WIND - FLOOD	TSUNAMI					Y	FEI	MA
Building Damage By G	General Occupancy					and the party of t		
June 20, 2018						All values are	in thousands	of square feet
	_	Sq	juare Foota	ge Distribu	tion by Dar	nage Perce	nt Range	
	Total Dmg Square Footage	< 1	1-10	11-20	21-30	31-40	41-50	Substantial
Virginia								
Montgomery								
Education	25.35	0.63	10.24	5.72	1.87	0.00	0.11	6.78
Government	1.31	0.05	0.18	0.44	0.17	0.17	0.10	0.20
Residential	1,152.98	59.71	57.02	137.32	134.88	116.97	108.86	538.23
Industrial	177.59	0.59	8.24	23.53	48.56	62.10	20.22	14.35
Agriculture	14.84	0.33	1.12	2.84	2.32	1.73	2.46	4.05
Commercial	73.99	0.78	6.99	21.35	14.96	11.73	10.42	7.77
Religion Total	21.86	1.10 63.19	1.83 85.62	15.32	1.44 204.21	0.43	0.56	1.18
Total	1,467.91	63.19	05.02	200.50	204.21	193.13	142.63	572.53
Total	1,467.91	63.19	85.62	206.50	204.21	193.13	142.73	572.53
Scenario Total	1,467.91	63.19	85.62	206.50	204.21	193.13	142.73	572.53
Study Region: MontVA								Page:1of3
Scenario: test								
Return Period: 100								

Figure 8-37: Example – Building Damage By General Occupancy Summary Report

Figure 8-38: Report Export

Export	— ×
Format: Adobe Acrobat (PDF)	ОК
Destination:	Cancel

Table 8-1: List of Summary Reports

Tab	Report	Description
Inventory	Agricultural Products Dollar Exposure	Dollar exposure (in thousands of dollars) of the agricultural products in the Study Region.
Inventory	Building Stock Dollar Exposure by Building Type	Dollar exposure (in thousands of dollars) of the building stock by building type in the Study Region.
Inventory	Building Stock Dollar Exposure by Occupancy	Dollar exposure (in thousands of dollars) of the building stock by occupancy in the Study Region.
Inventory	Transportation Systems Dollar Exposure	Dollar exposure (in thousands of dollars) of the transportation systems in the Study Region.
Inventory	Utility System Dollar Exposure	Dollar exposure (in thousands of dollars) of the utility system in the Study Region.
Inventory	Vehicle Dollar Exposure (Day)	Dollar exposure (in thousands of dollars) of vehicles (during the day) in the Study Region.
Inventory	Vehicle Dollar Exposure (Night)	Dollar exposure (in thousands of dollars) of vehicles (during the night) in the Study Region.
Buildings	Building Damage by Building Type	Building damage (square footage distribution by percent damage) by building type caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage by General Occupancy	Building damage (square footage distribution by percent damage) by general occupancy caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage by General Occupancy (Post-FIRM)	Building damage (square footage distribution by percent damage) by general occupancy (Post-FIRM) caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage by General Occupancy (Pre-FIRM)	Building damage (square footage distribution by percent damage) by general occupancy (Pre-FIRM) caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage Count by General Building Type	Building damage (building count by percent damage) by general building type caused by the hazard in the scenario.
Buildings	Building Damage Count by General Occupancy	Building damage (building count by percent damage) by general occupancy caused by the hazard in the scenario.

Tab	Report	Description
Buildings	Building Damage Count by General Occupancy (Post- FIRM)	Building damage (building count by percent damage) by general occupancy (Post-FIRM) caused by the hazard in the scenario.
Buildings	Building Damage Count by General Occupancy (Pre- FIRM)	Building damage (building count by percent damage) by general occupancy (Pre-FIRM) caused by the hazard in the scenario.
Buildings	Emergency Operation Center Damage & Functionality	Damage and functionality of Emergency Operation Center caused by the hazard in the scenario.
Buildings	Fire Station Damage & Functionality	Damage and functionality of Fire Stations caused by the hazard in the scenario.
Buildings	Hospital Damage & Functionality	Damage and functionality of Hospitals caused by the hazard in the scenario.
Buildings	Police Station Damage & Functionality	Damage and functionality of Police Stations caused by the hazard in the scenario.
Buildings	School Damage & Functionality	Damage and functionality of Schools caused by the hazard in the scenario.
Lifelines	Highway Bridge Damage & Functionality	Damage and functionality of Highway Bridges caused by the hazard in the scenario.
Lifelines	Light Rail Bridge Damage & Functionality	Damage and functionality of Light Rail Bridges caused by the hazard in the scenario.
Lifelines	Potable Water Facility Damage	Damage to Potable Water Facilities caused by the hazard in the scenario.
Lifelines	Railroad Bridge Damage & Functionality	Damage and functionality of Railroad Bridges caused by the hazard in the scenario.
Lifelines	Wastewater Facility Damage	Damage to Wastewater Facilities caused by the hazard in the scenario.
Induced	Debris Generated	Estimated total of debris generated (in tons) by the hazard in the scenario.
Losses	Annualized Direct Economic Losses for Buildings	Annualized direct economic losses (in thousands of dollars) for buildings resulting from the hazard in the scenario.
Losses	Combined Wind and Surge Loss	Direct economic losses (in thousands of dollars) for the combined results from wind and flood hazards in a storm surge scenario.
Losses	Depreciated Direct Economic Losses for Buildings	Depreciated direct economic losses (in thousands of dollars) for buildings resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Agricultural Products	Direct economic losses (in thousands of dollars) for agricultural products resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Buildings	Direct economic losses (in thousands of dollars) for buildings resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Transportation	Direct economic losses (in thousands of dollars) for transportation resulting from the hazard in the scenario.
Losses	Direct Economic Losses for UDFs	Direct economic losses for user-defined facilities (UDFs) resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Utilities	Direct economic losses (in thousands of dollars) for utilities resulting from the hazard in the scenario

Tab	Report	Description
Losses	Direct Economic Losses for Vehicles (Day)	Direct economic losses (in thousands of dollars for vehicles (during the day) resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Vehicles (Night)	Direct economic losses (in thousands of dollars) for vehicles (during the night) resulting from the hazard in the scenario.
Losses	Indirect Economic Impact with Aid	Income and Employment impact (in millions of dollars) with outside aid resulting from the hazard in the scenario.
Losses	Indirect Economic Impact without Aid	Income and Employment impact (in millions of dollars) without outside aid resulting from the hazard in the scenario.
Losses	Shelter Requirements	Estimated number of households that are expected to be displaced; and of those households, estimated number of people to seek temporary shelter in public shelters as a result of the hazard in the scenario.
Other	Flood Global Risk Report	Includes general description of the region, building exposure by occupancy type (one for the Study Region and another for the scenario), expected building damage by occupancy and expected building damage by building type, expected damage to Essential Facilities, debris generated, shelter requirements, building-related economic loss estimates, and regional population and building value data.
Other	Quick Assessment	Includes regional statistics (area in square miles, number of census blocks, number of buildings, number of people in the region, building exposure) and scenario results (shelter requirements and economic loss)

9 Model Menu: Other Items

This section addresses the **File** menu, the **Help** menu, and the **Customize** menu. The primary focus is on any menu items that are different in the Hazus version of ArcMap compared with a typical ArcMap instance.

9.1 File Menu

The **File** menu, shown in Figure 9-1, is largely the same as the usual ArcMap File menu. The only two differences are the first two items: **Switch Hazard...** and **Study Region Wizard...**.

File	
7	Switch Hazard
4	Study Region Wizard
	Save Ctrl+S
	Save As
	Save A Copy
	Share As 🔹 🕨
	Add Data 🔸
	Sign In
	ArcGIS Online
	Page and Print Setup
	Print Preview
e	Print
	Export Map
I	Analyze Map
8	Map Document Properties
	1 C:\HazusData\Re\hazusFI.mxd
	2 C:\HazusData\R\HazusHu.mxd
	3 C:\HazusData\Re\hazuseq.mxd
	4 C:\HazusData\R\HazusHu.mxd
	5 C:\HazusData\Re\hazusFl.mxd
	6 C:\HazusData\Re\hazusFl.mxd
	7 C:\HazusData\Re\hazusFl.mxd
	8 C:\HazusData\R\HazusHu.mxd
	Exit Alt+F4

Figure 9-1: Hazus File Menu

The **Switch Hazard** option opens the **Select Hazard** dialog (Figure 9-2), which allows the user to switch between hazard types if the region was created with multiple hazards. Figure 9-2 shows an example related to storm surge where the Study Region has data and analyses for both the Hurricane Model and the Flood Model. When the user selects a new hazard, ArcMap will close and re-open with the selected hazard.

Select Hazard	
The region you have selected has data for the hazards listed below. You can only work on one hazard at a time.	
You can always switch hazards at any time from the study region menu.	
Please select the hazard to be current when your region is opened.	
 Earthquake 	
I Flood	
Murricane	
🔘 Tsunami	
OK Cancel	

Figure 9-2: Select Hazard Dialog

The **Study Region Wizard...** option opens the Hazus startup screen (Figure 9-3). The only option available is **Open a region**. Click **OK** to select from any of the previously created regions and launch ArcMap.

Hazus Startup	
Q .	Welcome to Hazus. In order to use Hazus, you need to define the study region to be used
ND • FLOO	in the analysis. Please select the desired option below, and a wizard will guide you through the necessary steps.
N.	 Create a new region Open a region
QUAKE	 Delete a region Duplicate a region Export/Backup a region
EARTH	C Import a region

Figure 9-3: Study Region Wizard

The remaining File menu options are the same as those normally found in ArcMap. Please refer to ESRI documentation for any questions regarding these options.

9.2 Help Menu

The **Help** menu, shown in Figure 9-4, is largely the same as the usual ArcMap Help menu. The only two differences are the **Obtaining Technical Support...** and **About Hazus-MH** options.

Figure 9-4: Hazus Help Menu



Selecting the **Obtaining Technical Support...** option will open the **Technical Support** window (Figure 9-5), which provides a phone number and email address for the user to refer any technical questions regarding Hazus.



Technical Support	ĸ
You may obtain technical assistance for Hazus by calling 1-877-FEMA MAP (1-877-336-2627) or sending an email to: hazus-support@riskmapcds.com.	
OK	

Selecting the **About Hazus-MH** option will open the **About Hazus-MH** window (Figure 9-6), which shows the copyright information for Hazus.

Figure 9-6: About Hazus Window

A	bout Hazus	×
	Hazus 4.2.1 Release : 15.2.1 Copyright © 1997-2018 Federal Emergency Management Agency. Developed by the Department of Homeland Security/Federal Emergency Management Agency.	
	OK	

The remaining options on the Help menu are the same as those normally found in ArcMap. Please refer to Esri documentation for any questions regarding these options.

9.3 Customize Menu

The **Customize** menu, shown in Figure 9-7, is largely the same as the usual ArcMap Customize menu. The only addition to the menu is **Flood Options...**

Figure 9-7: Hazus Customize Menu



Selecting **Flood Options...** will open the **Flood Options** window (Figure 9-8), which has four tabs: **Startup Options** (Figure 9-8), **Raster Options** (Figure 9-9), **Automation** (Figure 9-10), and **Repository** (Figure 9-11). The **Startup Options** tab gives the user some choices of what will appear when a Hazus ArcMap document is launched.

Figure 9-8: Flood Options (Startup Options) Window

Flood Options	
Startup Options Raster Options Automation Repository	
Always show DEM (if available)	
Always show computed Reaches (if available)	
🔽 Open last Scenario (if available)	
Show redo analyses Warning message box(es)	
Automatically remove problem reach(es)	
2000 CustomBuffer (default: 2000 m)	
OK Cancel	
The **Raster Options** tab gives the user control over how rasters will be symbolized and displayed in the Table of Contents.

Flood Options			-X
Startup Options	Raster Options	Automation	Repository
🗖 Automatica	lly Merge multiple	e DEM paths wit	hout asking
Default raster t	ransparency:	50	(0-100%)
		ОК	Cancel

Figure 9-9: Flood Options (Raster Options) Window

The **Automation** tab (**Figure 9-10**) allows the user the set the parameters for a scenario to run from stream networks. To run:

- 1. Select the **Run Automation** checkbox.
- 2. Enter the Drainage Area for the Study Region.
- 3. **DEM Path** is automatically included based on the previous DEM analysis. Editing the path will have no effect on the DEM or **DEM Path**.
- 4. Enter a **Scenario Name** (the name must be unique). All reaches that are developed by the stream network will be selected and included in the scenario.
- 5. Select a **Return Period**. If the user selects the **Single** return period, Hazus will run through the GBS analysis. If the user selects the **Suite** option, Hazus will run through the GBS analysis *and* the AAL analysis.
- 6. Click OK.

Flood Options
Startup Options Raster Options Automation Repository
Bun Automation
Drainage Area: (0.25 - 400 sq miles.)
DEM Path: C:\HazusData\Regions\Montgomeryl
Scenario Name:
Return Period: Single 🔹 100 👻
OK Cancel

Figure 9-10: Flood Options (Automation) Window

The **Repository** tab allows the user to control where output data is stored.

Figure 9-11: Flood Options (Repository) Window

Flood Options
Startup Options Raster Options Automation Repository
Output Results to Repository
Repository Instance :
.\HAZUSPLUSSRVR Verify
Repository Database : Verify
OK Cancel

The remaining items on the **Customize** menu are the same as those normally found in ArcMap. Please refer to ESRI documentation for any questions regarding these options.

10 Advanced Hazus Analysis: User-Defined Inventory Data

The Hazus default data inventory provides many datasets that support analysis, but in certain areas, a custom dataset may be more relevant to the Study Region being analyzed. Although Hazus data for a given location includes default inventory data for most data types, users may want to edit existing data or input their own data for certain type of analysis. The recommendation to users is to perform all data editing and entry using the Hazus Comprehensive Data Management System (CDMS) (Figure 10-1). CDMS will use Hazus Flood Model default values when critical attributes have not been populated (see Section 10.1 for default values). When CDMS is used to update the user-defined inventory data at the state level, these updated data will automatically be included in any Hazus Study Regions for that state. Details on using CDMS and data requirements can be found in the *Hazus Comprehensive Data Management System User Guidance*.

🎎 Comprehensive Data Management System (CI	OMS)						_ • •
File Tools 🥝 Help							
Welcome to the Hazus-MH Comprehensive Data Management System							
Please select one of the following:	CDMS	Repository	(Not yet transferred inf	o Statewide Layers)			
Import into CDMS Repository from File		Cate	egory Lay	er Ro	ecords U	Ipload Date	Uploaded By
Import into CDMS Repository from Hazus-MH Study Region							
Building-Specific Data							
Query/Export Statewide Datasets					ſ		
Update Study Region with Hazus-MH Data						Transfer to Stat	ewide Dataset
	Statewi	de Layer Mo	dification Histo		updates are displayed be right)	elow. To view all records	run the
		State	Category	Layer	Records	Upload Date	Uploaded By
Current State Please select HAZUS statewide							
Exit CDMS							

Figure 10-1: Hazus Comprehensive Data Management System

The Hazus Flood Model allows users to edit or import their own data. For example, **User-Defined Facilities**, which appears on the **Inventory menu**, allows the user to enter user-specific data sets to be analyzed through Hazus for more accurate results. The user will need to develop, external to Hazus, custom data for individual structures. For import into Hazus, these data need to be converted to a personal geodatabase (the only format Hazus currently supports for import).

To import the data, select **User-Defined Facilities** from the **Inventory** menu. The **User-Defined Structure Inventory** window (Figure 10-2) will open. Right click in the (empty) table to get the context menu. Select **Start Editing** and then **Import**.

🖭 User Defined Facilities					
User Defined					
ID	Name	Address	City	State	ZipCode 🔺
• 111		Add New Delete Se Import Export Data Dict Meta Dat	Record lected Records		E
				Close Map	Print

Figure 10-2: User-Defined Facilities Table

Navigate to the geodatabase (.mdb) with the data. Hazus will number the tables that are in the geodatabase and ask the user which table to use. The input file must be a point feature class within the .mdb.

Because the input data could be in any schema, Hazus will open the **Mapping** dialog to allow the user to convert the data from the input format to the target format, as shown in Figure 10-3. The list of fields in the input table will be shown on the left and will vary because the data inputs will be defined by the user. The list of the target fields will be shown on the right. This is the most critical step in the import process because it affects the data used and therefore the results obtained.

OBJECTID SHAPE USERDEFINE	ssign):		I OK I
CONTACT PHONENUMBE YEARBUILT BACKUPPOWE NUMSTORIES SHELTERCAP LATITUDE LONGITUDE LONGITUDE LONGITUDE LONGITUDE	PHONENUMBER YEARBUILT BACKUPPOWER SHELTERCAPACITY LONGITUDE COMMENT SHAPE BLDGTYPE DESIGNLEVEL		Cancel
		Add	
Mapping Results:		_	
	E		Delete
1 OCCUPANC OCCUPANC 2 NAME NAME		=	Clear All
2 NAME NAME 3 ADDRESS ADDRESS			
4 CITY CITY			
5 STATEA STATEA			Load
		Ŧ	
<	۰. F		Save

Figure 10-3: Mapping UDF Data Fields

10.1 UDF-Required Attributes

Table 10-1 presents the attributes required for analysis of UDFs within the Flood Model. If any of the attributes are not imported (i.e., mapped), Hazus will populate them with default values. Although those values can be edited later through the Hazus interface, doing so is not practical for such a large number of records. Therefore, having the correct values in the imported file is more efficient than editing them later.

Attribute	Description	Minimum Requirement	Field Type	Comments
ID	Hazus-assigned unique identifier for each record	Yes (generated by Hazus)	Text, Length: 8	If the user wants to include their own unique identifier for each structure, suggested fields are "Name" and "Comment."
Name	Structure name	No	Text, Length: 40	This field can be used for user's unique identifier for each structure, which may be local parcel ID if available.
Address	Structure street address	No	Text, Length: 40	
City	Structure city	No	Text, Length: 40	

Table 10-1: UDF Attribute Descriptions

Attribute	Description	Minimum Requirement	Field Type	Comments
State	Structure state	No	Text, Length: 2	
ZipCode	Structure zip code	No	Text, Length: 10	
Contact	Structure additional contact	No	Text, Length: 40	
Phone	Structure phone	No	Text, Length: 14	
Occupancy	Hazus-specific occupancy type	Yes	Text, Length: 5	Hazus will assume RES1 if unpopulated. See Hazus technical manuals or Hazus Inventory menu for detailed list of Hazus-specific occupancies.
BldgType	Building type per the Hazus model building types for flood	No	Text, Length: 15	Acceptable values are "Concrete," "ManufHousing," "Masonry," "Steel," and "Wood."
Cost	Building replacement cost = cost to replace the building in case of damage in whole dollars (not thousands)	Yes	Money, Length: 8, Precision: 19, Scale: 4	Primary source should be cost- estimating guides, such as RSMeans (\$/sqft), along with local square footage values from appraisal office (not local assessed or appraised values from these offices).
YearBuilt	Year structure was built	No	Smallint, Length: 2, Precision: 5	
Area	Building finished floor area in square feet	No	Real, Length: 4, Precision: 24	
NumStories	Number of stories in the building	Yes	Tinyint, Length: 1, Precision: 3	Hazus will assume 1 if not populated. See Table 10-2 for acceptable values.
DesignLevel	Design level of structure based on year built	No	Text, Length: 1	See Table 10-3 for acceptable values.
FoundationType	Foundation type of the structure	Yes	Text, Length: 1	Hazus will assume 7 (slab on grade) if not populated. See Table 10-4 for acceptable values. Used to determine with or without basement for RES1 occupancies.
FirstFloorHt	First floor height above grade	No	Float, Length: 8, Precision: 53	Value should be locally derived. Hazus will assume 0 if not populated. See Table 10-4 for acceptable values.

Attribute	Description	Minimum Requirement	Field Type	Comments
ContentCost	Contents replacement cost	No	Money, Length: 8, Precision: 19, Scale: 4	If not populated, Hazus will assume default value based on Cost and standard Hazus default contents value multiplier assumptions. See Hazus technical manuals or Hazus Analysis menu for specific multipliers.
BldgDamageFnId	Building Damage Function ID	No	Text, Length: 10	If not populated, Hazus will assume default value based on Occupancy, Number of stories, and Foundation Type. See Hazus technical manuals or Hazus Analysis menu for specific values.
ContDamageFnId	Contents Damage Function ID	No	Text, Length: 10	If not populated, Hazus will assume default value based on Occupancy, Number of stories, and Foundation Type. See Hazus technical manuals or Hazus Analysis menu for specific values.
InvdamageFnId	Inventory Damage Function ID	No	Text, Length: 10	If not populated, Hazus will assume default value based on Occupancy, Number of stories, and Foundation Type. See Hazus technical manuals or Hazus Analysis menu for specific values.
FloodProtection	Level of protection provided by a dam or levee in whole feet	No	Int, Length: 4 Precision: 10	Hazus will assume 0 if not populated. If near dam or levee, set value for level of protection in whole feet.
ShelterCapacity	Capacity, in number of people, for structure providing shelter	No	Smallint, Length: 2 Precision: 5	Not used in Hazus.
BUPower	ls backup power available?	No	Bit, Length: 1	No (default) = 0, Yes = 1. Not used in Hazus.
Latitude/Longitude	The location of the structure	Yes	Decimal, Length: 9, Precision: 11, Scale: 6	Imported data will pull location from spatial attributes of each structure point; manually entered data with Hazus user interface will require entering values when adding a UDF point.
Comment	Open text field	No	Text, Length: 40	Text field for additional information.

Occupancy	Number of Stories from Parcel Data	NumStories Value
RES1	1	1
RES1	2	2
RES1	3	3
RES1	Split-Level	4
RES2	1	1
RES2	2	2
RES2	3	3
RES3	1–2	1
RES3	3–4	3
RES3	5+	5
All other occupancies	1–3	1
All other occupancies	4–7	4
All other occupancies	8+	8

Table 10-2: NumStories Field Description

Table 10-3: DesignLevel Field Description

Year Built	Design Level Value
Prior – 1950	1
1950 – 1970	2
Post 1970	3
0 (set to Null)	0

Table 10-4: FoundationType Field and FirstFloorHt Field Description

Foundation Type from Parcel Data	FoundationType Value	Default FirstFloorHt (feet) Value
Pile	1	7
Pier	2	5
Solid Wall	3	7
Basement/Yard	4	4
Crawl Space	5	3
Fill	6	2
Slab on Grade	7	1

These values are based on Pre-FIRM construction for Riverine, Great Lakes, and Coastal Construction census blocks as defined through the Flood Specific Occupancy Mapping table.

10.2 UDF User-Supplied Inventory

The creation of user-supplied inventory can require varying levels 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 subject expertise. The greatest impact from enhanced inputs are produced by editing both the default inventory.

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

Running a baseline analysis for comparison with results after introduction of user-supplied data is recommended. 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 of documentation are essential.

In some cases, data collected 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 40-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. The easiest approach is to break the facility into different entries (i.e., records).

Consult the *Hazus Comprehensive Data Management System User Guidance* for specific information on use of that tool for data editing and entry.

11 Advanced Hazus Analysis: Hurricane Surge Scenario

The Hazus tool can run a combined hurricane and flood hazard analysis for coastal areas. In order to run a combined hurricane and flood hazard, a multi-hazard (flood and hurricane) Study Region that includes a shoreline must be built. To build the Study Region, follow the workflow shown in Table 11-1. The inputs will be used to determine the extent of flooding due to a wind-driven storm and estimate the flood losses associated with the hurricane.

Model	Inputs
Hurricane	 Define/Select Hurricane Scenario Run Analysis with Surge-Only or Surge and Waves Display Wind-Only Losses
Flood	 Select Coastal Surge Define Topography Define Scenario Delineate Floodplain Run Flood-Only Analysis Run Combined Loss Analysis
Hurricane or Flood	Display Combined Losses

Table 11-1: Workflow to Build Multi-Hazard Study Region

11.1 Storm Surge Scenario Options

The storm surge scenario options are available for four hurricane scenario types:

- User defined
- Hazus import
- Historic
- Hurrevac (hurricane evacuation tool) import (less than 24 hours before landfall); also see Section 6.3.3

The storm surge scenario options are not available for:

- Hurricane surface wind file (.dat file format)
- Probabilistic

To run a coastal surge analysis, the Study Region must have been created for both Hurricane and Flood Hazard analysis. As shown in Chapter 3, start with create a New Region Wizard (Figure 11-1). Check both **Flood** and **Hurricane** hazard boxes and click **Next**.

Create New Region	—
Hazard Type The hazard type controls the type and amount of data that will be aggregated. The hazard type selected affects the analysis options that will be available.	
Your study region can include one or more of the following hazards. Check below the hazard(s) you are interested in.	
🔲 Earthquake	
I Flood	
✓ Hurricane	
🔲 Tsunami	
Notes: 1. Selection of hazards listed above depends upon the hazard modules installed.	
Once a study region is built with a given hazard(s), it cannot be modified later on, in other words, you cannot add another hazard to it. Alternatively, you may re-create a similar region with different hazard(s).	
 If you are creating a Near Source only Tsunami region, please also check Earthquake checkbox. 	
< Back Next >	Cancel

Figure 11-1: Select Hazards for New Region

Specify the Study Region and finish the Create New Region wizard.

NOTE: Limiting coastal surge Study Regions to a single county is recommended. In some cases, a single county may need to be split into two regions.

Open a region and select the new multi-hazard. When prompted, select the Hurricane Model to open first, as shown in Figure 11-2. Click **Next** and then click **Finish** to open the region.

Figure 11-2: Select Hurricane Model First in Study Region

Open Region	x
Study region hazards selection If a region has data for multiple hazards, one only can be worked on at a time, and needs to be selected before the regions is opened.	¥
The region you have selected has data for the hazards listed below. You can only work on one hazard at a time.	
You can always switch hazards at any time from the study region menu.	
Please select the hazard to be current when your region is opened.	
C Earthquake	
C Flood	
 Hurricane 	
C Tsunami	
< Back Next > Cancel	

Analysis / Set Optimized Analysis Mode must be "Off," as shown in Figure 11-3.

Analysis	Results	Bookmarks	Insert	Select	
Darr	nage Funct				
Loss	Loss Functions				
Loss	of Use Fu	nctions			
Deb	Debris Functions				
Para	meters			۰	
Set (Optimized	Analysis Mode	OF	F	
Run					
Show	N Coastal S	Surge Status			

Figure 11-3: Ensure Optimized Analysis Mode is Off

Check **Hazard / Show Current** to make sure the scenario is set to manual, Hazus import, historical, or Hurrevac import (Figure 11-4). If the scenario needs to be changed, use **Hazard / Scenario** to open the Scenario Management Wizard discussed previously (Figure 11-5).

Figure 11-4: Review Scenario in Hazard / Show Current

Hazard	Analysis	Res
Sce	nario	
Sho	w Current	

Figure 11-5: Scenario Management Wizard



11.2 Run Storm Surge Analysis

Open the **Analysis Options** from the **Analysis / Run** menu (Figure 11-6). When storm surge is selected, as shown in Figure 11-7, a storm surge analysis using the National Oceanic and Atmospheric Administration (NOAA) Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model is executed in the Hurricane Model to produce estimates of coastal still water elevations. Note that the storm track that is used should extend beyond the outer boundary of the applicable SLOSH basin grids.

Analysis	Results	Bookmarks	Insert	Selecti	
Damage Functions					
Los	Loss Functions				
Los	s of Use Fu	nctions			
Del	Debris Functions				
Par	ameters			•	
Set	Optimized	Analysis Mode	e OF	F	
Rui	າ				
Sho	w Coastal :	Surge Status			

Figure 11-6: Analysis Run Storm Surge Menu



Figure 11-7: Analysis Options for Storm Surge

In addition, there are options for running coupled surge and wave analysis using the Delft University Simulating WAves Nearshore (SWAN) model if checked (refer to the Technical Manual for more details on the modeling approaches used for SWAN and SLOSH):

- Deep water and near shore wave models. A coarse analysis of the entire northwest Atlantic basin is run, and the results are then coupled into one or more nearshore wave grids, which are superimposed on the relevant SLOSH basin(s). This option is the most detailed and slowest running. The storm track used should also extend all the way out to 60 degrees west longitude when this option is selected.
- Near shore wave model only. This option runs a coupled surge and wave analysis within the relevant SLOSH basin(s) only. This option is faster than the first option but still significantly slower running than the "no waves" option.
- **No waves**. This option skips the SWAN model entirely. For this case, the Flood Model assumes depth-limited waves at the coastline rather than using significant wave heights produced by SWAN. This is the fastest option.

When appropriate boxes have been checked in the Analysis Options, click Run Analysis.

At the start of the analysis, the Hurricane Model prompts the user for an **initial water level** in feet with respect to the North American Vertical Datum (NAVD) 1988 datum shown in

Figure 11-8. This represents the water level along the coast that would have been expected (in the absence of the hurricane) near the center of the Study Region at the time of hurricane landfall. The initial water level can be estimated by using NOAA tide forecasts plus the prestorm tidal anomaly (i.e., the difference between the forecast and observed water level 2 days before landfall).

Initial Water Leve	I	
	er level in feet abo negative) mean se	
	0.000000	
ОК		Cancel

Figure 11-8: Provide Initial Water Level

When running a coastal surge hazard analysis (Figure 11-9) in the Hurricane Model, a second progress dialog will appear after the wind-only damage and loss calculations are completed (Figure 11-10).



Run Analysis
Analysis Progress
Total
Saving shelter results
Cancel

Figure 11-10: Run Storm Surge Progress Status Window

Run Storm Surge
Storm Surge Progress
Total
ComputeWind-01
Cancel

When a hurricane coastal storm surge analysis is run, two sets of direct building losses are produced: one set for the wind damage by itself and a second set for the combined wind and surge damage. When the coastal surge analysis is complete, click the **Analysis / Show Coastal Surge Status** to confirm that the analysis was successful, as shown by the status box in Figure 11-11.





To obtain the combined wind and surge losses, users must run a Coastal Surge analysis and calculate the combined losses in the Flood Model. See further instructions in the Hazus Flood Model Manual.

11.3 Storm Surge

After the Hurricane Model has been run, reopen the Study Region in the Flood Model.

View as Flood, shown in Figure 11-12. Click Next and then click Finish to open region.

Figure 11-12: Select Flood Model in Study Region

Open Region
Study region hazards selection If a region has data for multiple hazards, one only can be worked on at a time, and needs to be selected before the regions is opened.
The region you have selected has data for the hazards listed below. You can only work on one hazard at a time.
You can always switch hazards at any time from the study region menu.
Please select the hazard to be current when your region is opened.
C Earthquake
Flood
C Hurricane
O Tsunami
< Back Next > Cancel

Open the Hazard menu and select Flood Hazard Type (Figure 11-13).



Figure 11-13: Select Flood Hazard Type

Select the Flood Hazard type Coastal Surge and click OK (Figure 11-14).

Figure 11-14: Select Coastal Surge

Flood Hazard Type					
Study region flood hazard type					
Riverine only					
Coastal only					
Riverine and coastal					
Combined wind and flood					
Coastal surge					
OK Cancel					

After the hazard type is set, the user must import a DEM for the Study Region by opening the **Hazard** menu and selecting the **User Data** dialog (Figure 11-15).

Figure 11-15: Select User Data to Import DEM

Hazaro	Ana	alysis	Results	Bookr		
F	Flood Hazard Type					
L	ser Dat	a:				
D	evelop	Stream	n Network			
S	enario)		Þ		
R	verine			×		
C	oastal			•		
C	uick A	nalysis		►		

The **User Data** dialog will only contain two tabs, **DEM** and **Coastal Surge**. Use the **Browse** button to add the DEM to the Model (Figure 11-16). Figure 11-17 shows the **Coastal Surge** tab, where the Surge Elevation Grid (SLOSH) and Significant Wave Height Grid (SWAN) that were produced by the Hurricane Model are in the Study Region folder as surge.flt, surge.hdr (SLOSH), and waveht.flt, waveht.hdr (SWAN). When the DEM is uploaded, click **OK**. See the Hazus Flood Model Manual for more details about obtaining DEM data.

	Coastal Surge		
D	EM metadata		
	Vertical units	Feet	•
	Vertical datum	NAVD88	•
	Other vertical datum		
			Show
			Remove

Figure 11-16: Add User Data DEM to Model

User Data	
DEM Coastal Surge	
Surge Elevation Grid (SLOSH)	
C:\HazusData\Regions\Multi_Hazard\surge.flt	
Significant Wave Height Grid (SWAN)	
C:\HazusData\Regions\Multi_Hazard\waveht.ftt	
Progress	OK Cancel

Figure 11-17: Review User Data in Coastal Surge Tab

When the DEM uploads successfully, the user needs to create a new scenario next, using **Hazard / Scenario / New** (Figure 11-18). Enter a unique name for the scenario and click **OK** (Figure 11-19). In the coastal surge scenarios, the surge and wave height files are automatically selected, and users do not need to select or save any features because the Hurricane Model supports only one scenario per Study Region.

Hazard	Analysis	Results	Bookmarks	Insert	Select
Flo	od Hazard T	ype			
Use	User Data				
Dev	velop Strean	n Network			
Sce	Scenario 🕨 🕨		•	New	
Riv	erine		•	Open	
Co	astal		•	Save As.	
Qu	ick Analysis		•	Edit	
				Close	
				Delete	

Figure 11-18: Select New Scenario in Hazard Menu

Figure 11-19: Provide Name for New Scenario

Create New Scenario	23
Enter a unique name for the New Scenario:	
Brunswick	
Description	
surge analysis	
ОК	Cancel

If the user selected **No Waves** in the Storm Surge analysis for the Hurricane Model, only the surge elevation grid was created for the Study Region. The wave height grid (waveht.flt) was not produced and the shoreline needs to be characterized. In this case, after creating a new scenario, the shoreline limits dialog will pop up, as shown in Figure 11-20.

Shoreline Limits					
Optionally draw shoreline startline, endline, and breaklines. Single click to add a vertex and double click to finish drawing the line. For breaklines only, right click a line to remove it.					
Current shoreline					
< Previous Shoreline 1					
Limit type	Action				
Startline	Draw				
Breakline	Use Default				
Dieakine					
	Cancel Next >				

Figure 11-20: Input Shoreline Limits

After clicking **Next**, there will be an additional shoreline characterization dialog, as shown in Figure 11-21. The **Shoreline Type** tab has one required input (wave exposure).

Figure 11-21: Select Shoreline Characteristics

Shoreline Characteristics Current shoreline: <pre></pre>	Next Shoreline > Apply to All Segments
Shoreline Type	
Shoreline characterization Wave exposure	
Open coast (full exposure)	
	Cancel < Back Finish

The options for the wave exposure include:

- **Open coast (full exposure)**: Any shoreline where the storm surge and waves come directly off open waters without the benefit of barrier islands or other land mass protection. Think in terms of lines of waves marching directly onto the shoreline uninterrupted. Full exposure is the Hazus default.
- **Moderate exposure**: Best represented by a shoreline that is slightly protected from the storm surge and associated waves. Moderate exposure might be a shoreline that has small islands or a low-lying sandbar that help break the direct force of the waves on the shoreline. A shoreline with moderate exposure might be angled to the direct line of the waves and will therefore receive a portion of the wave front.
- **Minimal exposure**: Best represented by a shoreline that is not in direct line with the storm surge or the waves. Minimal exposure might include an exposed shoreline that is running close to parallel to the storm surge and is therefore not bearing the brunt of the wave fronts.
- **Sheltered**: Best represented by the shoreline within a bay or protected by a larger barrier island. Sheltered could also be a shoreline along a large river inlet. The shoreline is sheltered from the wave front and is most likely subjected to stillwater flooding.

The default parameter is **Open coast (full exposure)**. At the top of the screen, the user can switch from one shoreline segment (if more than one) to another and back. If there are multiple segments and most have a single characteristic and a few have unique characteristics, the user can save time and effort by applying the common characteristic to all segments by pressing **Apply to All Segments** and then editing the unique segments.

After selections, click Finish.

Proceed to **Delineate Floodplain** by going to the **Hazard** Menu and selecting **Coastal** (Figure 11-22). When it is finished, the completion window will be shown as in Figure 11-23.

Hazard	Analysis	Results	Bookmarks	Insert	Selection	Geop
Flo	od Hazard T	ype				
Use	r Data					
Dev	velop Strean	n Network				
Sce	nario		•			
Riv	erine		•			
Coa	astal		•	Delineat	te Floodplair	ı
Qui	ick Analysis		•	Long Te	rm Erosion	
				Shore P	rotection	

Figure 11-22: Select Coastal to Delineate Floodplain

Figure 11-23: Delineate Floodplain Completion Status Window



Figure 11-24 displays the completed hazard portion of a coastal surge model. The coastal surge model outputs a flood depth grid named "Mix0_c" to the map, which comprises SLOSH and wave height grids.



Figure 11-24: Example – Coastal Surge Floodplain Delineation

The next step to complete the analysis is by using the **Analysis** Menu and choose **Run** (Figure 11-25). Next, check the **General Building Stock Damage and Loss** option and click **OK (**Figure 11-26).

			-
Analysis	Results	Bookmarks	Inse
Dan	nage Funct	tions	•
Rest	Restoration Functions		•
Para	meters		•
Floo	d Warning	j	
Ave	Average Annualized Loss		
Con	nbined Wir	nd and Flood	
Qui	ck Analysis		
Run			

Figure 11-25: Select Run in Analysis Menu

Figure 11-26: Select Preferred Analysis Options

Analysis Options	
General Building Stock Damage and Loss General Building and Content Damage (%) Direct Economic Loss (\$) (Bldg, Cont, Inv) Demage Building Count Operceiated Building and Content Loss (\$) Essential Facilities User Defined Structures Transportation Systems Agricultural Products Oebris Direct Social Loss Indirect Economic Loss What-If	Select All Deselect All
C:\has 139.52 GB free space; [Multi_Hazard] is 476 MB (95.35% free)	ок
	Cancel

(

The final step of a storm surge analysis is to calculate the combined hurricane wind and coastal storm surge losses, using the **Analysis** Menu and selecting **Combined Wind and Flood...** (Figure 11-27). When the combined losses are completed, click **OK** to the message box (Figure 11-28).

Analysis	Results	Bookmarks	Inse		
Dan	Damage Functions Restoration Functions				
Rest					
Para	meters		×		
Floo	Flood Warning				
Ave	rage Annu:	alized Loss			
Cor	nbined Wir	nd and Flood			
Qui	Quick Analysis				
Run	Run				

Figure 11-27: Select Combined Wind and Flood to Calculate Losses

Figure 11-28: Combined Coastal Surge Status Window



When the analysis options have finished running, use the **Results Menu** (Figure 11-29) to **View Current Scenario Results By...**, select the scenario in the dropdown, and click **OK**, as shown in Figure 11-30.

Figure 11-29: Select View Current Scenario Results



View Results by		×
Scenario Name:		
Brunswick_Co		
Scenario Description:		
coastal surge		
Available Results:		
Mix0		-
Mix0		
What-If Options:		
	OK	Cancel

Figure 11-30: Select Available Results for Surge Analysis

The combined losses can be viewed either in the Flood Model or in the Hurricane Model using either the **Results / Combined Wind and Surge Loss** menu (Figure 11-31 and Figure 11-32) or the **Results / Summary Reports / Direct Losses – Combined Wind and Surge Loss** summary report. An example results table is shown in Figure 11-33.

Results	Bookmarks	Insert	Selection			
Viev	w Current Scer	nario Res	ults By			
Flo	od Hazard Maj	ps		Þ		
Ger	neral Building	Stock		Þ		
Cor	mbined Wind :	and Floo	d Loss			
Ess	Essential Facilities					
Use	r Defined Faci	lities				
Adv	/anced Buildin	g Analys	is			
Tra	Transportation Systems					
Util	Utility Systems					
Agr	icultural Prod	ucts				
Veh	icles					
Deł	oris					
Cas	ualties			Þ		
She	lter					
Ind	irect Economi	c Loss				
Qui	ick Analysis Re	port				
Sur	nmary Report:	5				

Figure 11-31: Select Combined Wind and Flood Loss Results (Flood Model)

	_			_		
Results	Bookmarks	Insert	Selection	Geopro	cessing	Customize
	orm Track		•	M 🖈	🕘 🖻	🔛 🛤 🛛
Wi	nd Speeds					
Ge	neral Building 🤅	Stock	+			
Co	mbined Wind a	and Surg	e Loss 🛛 🕨	by	Occupai	ncy
Est	ential Facilities			by	Building	Туре
Us	er Defined Facil	ities				
De	bris			1		
Sh	elter			1		
Su	mmary Reports			1		

Figure 11-32: Select Combined Wind and Surge Loss (Hurricane Model)

Figure 11-33: Example – Combined Surge Result Table

Results for Scenario: B	runswick				Return pe	eriod: Mix0
Residential	•	Pre-Firm	•			
	CensusBlock	BidgFloodLoss	BldgWindLoss	BldgCombLoss	ContFloodLoss	ContW
1	370190201011003	0.00	0.05	0.05	0.00	[
2	370190201011005	0.00	0.04	0.04	0.00	
3	370190201011006	0.00	0.05	0.05	0.00	
4	370190201011007	0.00	0.07	0.07	0.00	
5	370190201011009	0.00	0.05	0.05	0.00	
6	370190201011011	0.00	0.07	0.07	0.00	
7	370190201011014	0.00	0.23	0.23	0.00	
8	370190201011017	0.00	0.05	0.05	0.00	
9	370190201011018	0.00	0.30	0.30	0.00	
10	370190201011019	0.00	0.04	0.04	0.00	
11	370190201011020	0.00	0.94	0.94	0.00	
12	370190201011021	0.00	0.12	0.12	0.00	
13	370190201011024	0.00	0.92	0.92	0.00	
14	370190201011027	0.00	0.09	0.09	0.00	
15	370190201011029	0.00	0.09	0.09	0.00	
10						E.

Note that combined wind and surge results are available for building, content, and inventory losses but not for relocation, income, rental, or wage losses. The radio buttons and dropdown boxes allow the user to filter the losses by occupancy or building type.

Hazus has a limit of one scenario for the Coastal Surge flood hazard type. If the user already completed the coastal surge model in a Study Region and decides to re-run the Hurricane Model, the user must delete the previous flood scenario and re-input the DEM in the **User Data** dialog in the Flood Model.

12 Advanced Hazus Analysis: Import User-Defined Data

Users have the option to bypass processing the DEM if they plan to run a scenario that only includes the Flood Information Tool (FIT) projects, flood depth grids, and/or USACE Hydrologic Engineering Center's River Analysis System (HEC-RAS) .FLT grids. The Hazus Program recommends users import their specific flood hazard information from external sources via depth grids, HEC-RAS, or other hydrologic and hydraulic model.

12.1 Import FIT Results

The FIT is an ArcGIS extension separate from Hazus that can be used to create flood hazard data for import to Hazus. The data are prepared outside of Hazus and then imported into the model. For more information regarding FIT, see the *Flood Information Tool User Manual*.

To import FIT data, select **User Data** from the **Hazard** menu. In the **User Data** window, select the **FIT** tab, as shown in Figure 12-1. Depending on the flood hazard type selected earlier, a **Riverine** and/or **Coastal** tab will be available.

Use the **Browse...** button to navigate to the location of the FIT working directory. The browse dialog is intended to select a folder, not the contents of it, so click on the working directory (do not double-click). Import the FIT working directory into the correct hazard tab. Repeat the process to import additional FIT working directories.

User Data
DEM FIT Depth Grid HEC-RAS
Select FIT folders
Riverine Coastal
Remove
Progress OK Cancel

Figure 12-1: Select FIT Tab to Import FIT Data

12.2 Import Flood Depth Grid Results (preferred method for importing flood hazard information)

To import flood depth grid results into Hazus, select **User Data** from the **Hazard** menu. In the **User Data** window, select the **Depth Grid** tab, as shown in Figure 12-2. The format of user supplied depth grids can be Esri GRID, IMAGINE (.IMG), HEC-RAS (.FLT), tagged image file (.TIF), and file geodatabase (fGDB).

Use the **Browse...** button to navigate to the location of the flood depth grid. The browse dialog is intended to select a raster. After importing the flood depth grid, select the newly imported flood depth grid and click the **Set Parameters** button. A **Set Parameters** window will appear (Figure 12-3). Use the drop-down menu to select the **Units** (feet or meters), and then input the **Return Period** of the flood depth grid. It is important that users import the flood depth grid into the correct hazard tab. Repeat the process to import additional flood depth grids.

User Data	
DEM FIT Depth Grid HEC-RAS	
Select depth grids Riverine Coastal	
C:ttemp1DepthGrids1Finaldepth1cdepth100wgs	Browse Remove Set Parameters
Progress	OK Cancel

Figure 12-2: Select Depth Grid Tab to Import Depth Grid Data

Figure 12-3: Set Parameters for Depth Grid Dialog

Depth grid parameters		
Units:		T
	Feet Meters	13
Return period (optional):	Meters	
(-)		
	ОК	Cance

12.3 Import HEC-RAS .FLT Grid Results (preferred method for importing flood hazard information)

Users of HEC-RAS can import HEC-RAS (via RAS Mapper) hydraulic output .FLT grids to be used in the Flood Model. The HEC-RAS .FLT grids are implicitly treated as Riverine. To import HEC-RAS .FLT grid results into Hazus, select **User Data** from the **Hazard** menu. In the **User Data** window, select the **HEC-RAS** tab, as shown in Figure 12-4.

Use the **Browse** button to navigate to the HEC-RAS (produced via RAS Mapper) hydraulic output .FLT grid. The browse dialog is intended to select a floating-point binary file. After the .FLT grid is selected, the Flood Model validates the input by making sure the .FLT grid's associated floodplain boundary (by default HEC-RAS saves it as FloodMap) is located partially within the Study Region (geographically) and contains projection information (prj.adf). The Flood Model does not validate the integrity between the .FLT grid and the floodplain boundary polygon (by default HEC-RAS saves it as FloodMap). A status bar, shown at the bottom of the window in Figure 12-4, will indicate the level of progress as the data is imported and validated.

Select the newly imported .FLT grid and click the **Set Parameters** button. A **Set Parameters** window will appear (Figure 12-5). Use the drop-down menu to select the **Units** (feet or meters), and then input the **Return Period** of the flood depth grid. Repeat the process to import additional HEC-RAS .FLT grids.

	t HEC-RAS grids	ut.flt	*	Browse Remove Set Parameters
4			 	
/alidated th	e HEC-RAS .fit file		ок	Cancel

Figure 12-4: Select the HEC-RAS Tab to Import .FLT Grid Data

Figure 12-5: Set Parameters for .FLT Grid Dialog

Depth grid parameters		
Units:	Feet •	
Return period (optional):	500	
	ок са	ancel

13 Quick Look and Enhanced Quick Look

The **Quick Look** and **Enhanced Quick Look** analyses allow the user to quickly produce a rough estimate of flood damages, without working through the entire process of generating a stream network or delineating a floodplain either within Hazus or from external modeling tools. For the **Quick Look** analysis, the user delineates a polygon of equal flood depth that is used to conduct a "quick" analysis for GBS only. For the **Enhanced Quick Look** analysis, the user imports a polygon that represents the floodplain boundary and the DEM for the area of this boundary, and then Hazus estimates the flood depth for areas within the imported boundary. Like **Quick Look**, **Enhanced Quick Look** only calculates GBS losses.

This chapter includes step-by-step instructions on how to perform a Quick Look and Enhanced Quick Look analysis. These steps assume the user has already created and opened a Study Region as detailed in Chapter 3.

13.1 Select Flood Hazard Type

Launch Hazus and open the new Study Region created specifically for a **Quick Look** or **Enhanced Quick** analysis.

Select a **Flood Hazard Type** to perform either a **Quick Look** or **Enhanced Quick Look** analysis. For example, to perform a riverine analysis, open the **Hazard** menu and select **Flood Hazard Type** (Figure 13-1) to open the **Flood Hazard Type** window (Figure 13-2). Select **Riverine only**, and click **OK**. A similar approach would be used if the analysis were for coastal flooding, by selecting **Coastal only**.



Figure 13-1: Select Flood Hazard Type in Hazard Menu



Figure 13-2: Select Flood Hazard Type

13.2 Perform Quick Analysis

After selecting the **Flood Hazard Type**, proceed directly to the Quick Analysis by opening the **Hazard** menu and selecting **Quick Analysis** (Figure 13-3). The user does not need to enter **User Data** nor define a **Scenario**, which are typically required for a flood analysis within Hazus.

	rigure 15-5. Quick	Analysis Menu
	Hazard Analysis Results Bookm	arks Insert Selection Geopro
5	Flood Hazard Type	- 🔀 🗔 🗐 🔁
	User Data	A 📸 🕺 💿 💽 📮
	Develop Stream Network	
	Scenario 🕨	
	Riverine •	
	Coastal •	1 SCT
	Quick Analysis	Quick Look
		Enhanced Quick Look

Figure 13-3: Quick Analysis Menu

13.2.1 Quick Look

To conduct a **Quick Look** analysis, select **Quick Look** from the **Hazard / Quick Analysis** menu as shown in Figure 13-3. This will open the **Quick Look** dialog (Figure 13-4).

Figure 13-4: Quick Look Dialog

S Quick Look
Draw a Quick Look polygon and assign a flood depth. To draw, single click to add a vertex and double click finish to drawing. Repeat to add additional polygons.
Draw Polygon Shape
Flood Depth
Depth (feet): Save
OK Cancel

Click **Draw** in the **Quick Look** dialog. Using the cursor, draw a polygon with as many sides as desired, as illustrated with the yellow line in Figure 13-5. Double-click when the polygon is complete. Next, enter a **Flood Depth** for the polygon in the **Quick Look** dialog. Click **Save**, and then click **OK**.



Figure 13-5: Drawing a Polygon for Quick Look

Only one **Quick Look** analysis can be performed in a given Study Region. Additional **Quick Look** analysis efforts will overwrite the results from the previous analysis. **Quick Look** will not run if a scenario is open. It is independent from the scenario(s).

After the **Quick Look** analysis has been completed, the Hazus window will show a depth grid of equal flood depth in the location where the user delineated the floodplain boundary.

13.2.2 Enhanced Quick Look

To conduct an **Enhanced Quick Look** analysis, select **Enhanced Quick Look** from the **Hazard** */* **Quick Analysis** menu as shown in Figure 13-6.



Figure 13-6: Enhanced Quick Look Menu

The **Enhanced Quick Look** window will appear (Figure 13-7). From the dropdown menus, select the **Vertical units** and **Vertical datum** of the polygon representing the floodplain boundary. Browse to the appropriate file locations for the DEM and single continuous floodplain boundary polygon, as illustrated in Figure 13-8. Click **OK** to start the analysis.

Enhanced Quick Look	
Enhanced Quick Look	
Vertical units	
Vertical datum	
Other vertical datum	
Select DEM dataset location	Browse
	Show
Floodplain Boundary Locatio	n
	Browse
Full damage	Show
	OK Cancel

Figure 13-7: Blank Enhanced Quick Look Window

Enhanced Quick Look]		
DEM metadata			
Vertical units	Feet		•
Vertical datum	NAVD88		•
Other vertical	datum		
Select DEM datase			Browse
C. LEMPLOL WECK			Show
Floodplain Boundar	y Location		
C:\temp\EQL\UserE	oundary\FloodBoundary.shp		Browse
Full damage			Show
		ок	Cancel

Figure 13-8: Completed Enhanced Quick Look Window

While the **Enhanced Quick Look** analysis is running, a status bar, shown at the bottom of the **Enhanced Quick Look** window in Figure 13-9, will indicate the level of progress of the analysis.

Only one **Enhanced Quick Look** analysis can be performed in a given Study Region. Additional **Enhanced Quick Look** analysis efforts will overwrite the results from the previous analysis. **Enhanced Quick Look** will not run if a scenario is open. It is independent from the scenario(s). If the user selects the **Full damage** checkbox, the Flood Model will make flood depth assumptions to maximum damage levels.

Enhanced Quick Look		
DEM metadata		
Vertical units	Feet	~
Vertical datum	NAVD88	
Other vertical datum		
Select DEM dataset locatio	n	
C: \temp\EQL\MeckDEM\me	ckdem	Browse
		Show
-Floodplain Boundary Loca	tion	
C:\temp\EQL\UserBounda	y\FloodBoundary.shp	Browse
🔄 Full damage		Show

Figure 13-9: Enhanced Quick Look Window Status Bar

After the **Enhanced Quick Look** analysis has been completed, the Hazus window will show the imported floodplain boundary with a depth grid of varying depths within the boundary, as shown in Figure 13-10.



Figure 13-10: Example of Enhanced Quick Look Flood Depth Grid

13.3 Run Losses for Quick Analysis

To run losses for a Quick Analysis after completing either a **Quick Look** or **Enhanced Quick Look** analysis under the **Hazard** menu, open the **Analysis** menu and select **Quick Analysis** (Figure 13-11).

Figure 13-11: Quick Analysis Menu



A progress bar (Figure 13-12) will appear as Hazus performs a flood loss analysis

Figure 13-12: Quick Analysis Progress Window



A notification (Figure 13-13) will appear once the flood loss analysis (only for GBS data) has been completed. Click **OK**.

Figure 13-13: Quick Analysis Completed



13.4 Generate Quick Analysis Loss Report

After running the loss analysis for **Quick Look** or **Enhanced Quick Look**, the user will be able to review the loss results by generating a special report exclusively for the Quick Analysis. This report is created by selecting **Quick Analysis Report** from the **Results** menu (Figure 13-14). This report provides the only way to access the loss results for a **Quick Analysis**.

Results	Bookmarks	Insert	Selection	(
Vie	w Current Sce	nario Res	ults By	
Flo	od Hazard Ma	ps		Þ
Ge	neral Building	Stock		Þ
Co	mbined Wind	and Floo	d Loss	
Ess	ential Facilitie:	5		
Us	er Defined Faci	lities		
Ad	vanced Buildir	ig Analys	is	
Tra	Insportation Sy	/stems		
Uti	lity Systems			
Ag	ricultural Prod	ucts		
Ve	hicles			
De	bris			
Ca	sualties			Þ
Sh	elter			
Inc	lirect Economi	c Loss		
Qu	iick Analysis Re	eport		
Su	mmary Report	s		

Figure 13-14: Quick Analysis Report Menu

The **Quick Look Summary Report** (Figure 13-15) consists of two-page report summarizing the GBS results.



Figure 13-15: Quick Analysis Summary Report

14 Acronyms and Abbreviations

.dat	hurricane surface wind file
.fGDB	file geodatabase file
.FLT	floating-point binary
.hpr	Hazus Packaged Region, file extension used for exported Hazus study regions
.IMG	IMAGINE file
.mdb	geodatabase file
.TIF	tagged image file
DEM	digital elevation model
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FIT	Flood Information Tool
GBS	General Building Stock
GIS	geographic information system
HEC-RAS	Hydrologic Engineering Center's River Analysis System
Hurrevac	hurricane evacuation tool
NAVD	North American Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
RES1	Single Family
SLOSH	Sea, Lake, and Overland Surges from Hurricanes (model)
SWAN	Simulating WAves Nearshore (model)
SWEL	stillwater elevation
UDFs	User-Defined Facilities
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WHAFIS	Wave Height Analysis for Flood Insurance Studies

15 Glossary

Advanced Level 2 analysis. An Advanced Level 2 analysis improves Level 1 results by considering additional data that are readily available or can be easily converted or computed to meet methodology requirements.

Advanced Level 3 analysis. An Advanced Level 3 analysis requires effort by the user to develop and update information concerning the underlying engineering and loss analysis parameters in Hazus. This type of analysis incorporates results from engineering and economic studies carried out using methods and software not included within the methodology.

Average annualized loss (AAL). The AAL is the mean value of a loss exceedance probability (EP) distribution. It is the expected loss per year, averaged over many years.

Basic Level 1 analysis. A Basic Level 1 analysis is the simplest type of analysis requiring minimum effort by the user. It is based primarily on data provided with the software (e.g., census information, broad regional patterns of foundation distributions, no floodplain code adoption).

Coastal flood hazard. Flooding hazards along the coast that have additional hazards due to wind or wave action.

Depth-damage functions. A way of expressing expected flood damages for various types of buildings, their contents, or their functions at different water depths. For floods, this relationship is expressed as depth versus percentage damage to the element being considered.

Depreciation parameters. The parameter for the depreciation of buildings is based on the age of the building. These parameters are used to determine the depreciated exposure of a census block.

Deterministic scenario. Considers the impact of a single-risk scenario.

Digital Elevation Model (DEM). A data file that contains digital representations of cartographic information in raster form. DEMs consist of a sampled array of elevations from a number of ground positions at regularly spaced intervals.

Direct economic loss. 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.

Erosion. The collapse, undermining, or subsidence of land along the shore of a lake or other body of water. Erosion is a covered peril if it is caused by waves or currents of water exceeding their cyclical levels that result in flooding.

Essential facilities. Facilities that, if damaged, would present an immediate threat to life, public health, and safety. As categorized in Hazus, essential facilities include hospitals, emergency operations centers, police stations, fire stations, and schools.

First floor elevation. This is the elevation of the top of the lowest finished floor in a building. The relationship between the first floor elevation and the Base Flood Elevation at a site determines the extent of flood risk.

Flood Information Tool (FIT). The FIT is an ArcGIS extension separate from Hazus that can be used to create flood hazard data for import to Hazus. The data are prepared outside of Hazus and then imported into the model. For more information regarding FIT, see the *Flood Information Tool User Manual.*

Floodplain. Any land area susceptible to being inundated by floodwaters from any source.

Forecast. To calculate weather trend in advance of a future storm with uncertainties.

General Building Stock (GBS). Building database that includes square footage by occupancy and building type, building count by occupancy and building type, valuation by occupancy and building type, and general occupancy mapping.

Hazard. An act or phenomenon that has the potential to produce harm or other undesirable consequences to a person or thing.

Hazardous materials facilities. Facilities housing hazardous materials such as corrosives, explosives, flammable materials, radioactive materials, and toxins.

Hazus. GIS-based risk assessment methodology and software application created by FEMA and the National Institute of Building Sciences for analyzing potential losses from floods, hurricane winds and storm surge, earthquakes, and tsunamis.

High Potential Loss Facilities. Facilities that, if damaged, could result in a high threat to life or release hazardous materials. Examples include nuclear power plants, dams, and military installations.

Lifeline systems. Utility systems that provide essential services for communities. Examples include roads and highways, rail, potable water, and wastewater systems.

Loss ratio. Loss as a fraction of the value of the local inventory (total value/loss).

Mitigation. Action to reduce the potential loss of life and damage to property by reducing the impact of disasters.

Probabilistic scenario. Considers the associated impacts of many thousand potential storms that have tracks and intensities reflecting the full spectrum of Atlantic or Central Pacific hurricanes.

Replacement value. The cost of rebuilding a structure. This is usually expressed in terms of cost per square foot and reflects the present-day cost of labor and materials to construct a building.

Risk. Estimated impact that of hazard on people, services, facilities, and structures in a community.

Riverine flood hazard. Hazards related to or produced by a river.

Scenario. A scenario defines the specific stream reaches, or lengths of coastline for coastal users, and the hydrologic and hydraulic characteristics to be included in one analysis run.

Storm surge. The abnormal rise in seawater level during a storm, measured as the height of the water above the normal predicted astronomical tide.

Stream network. Delineated streams from a DEM in a study region.

Study Region. The county, watershed, or community being created for the analysis.

SWAN (Simulating WAves Nearshore). Third-generation wave model, developed at Delft University of Technology that computes random, short-crested wind-generated waves in coastal regions and inland waters.

Transportation systems. The lifeline systems that include airways, highways, railways, and waterways.

User-defined facility (UDF). Building at a specific location that is added to the inventory.

User-supplied inventory. Enhanced inputs that are produced by editing both the basic inventory and updating the model parameters.

Utility systems. The lifeline systems that include potable water, wastewater, oil, natural gas, electric power, and communication systems.

Valuation parameters. The parameters for determining the replacement cost value for a building type.

Vulnerability. The susceptibility of an asset to physical injury, harm, damage, or economic loss.