STEP 1d: VULNERABILITY ASSESSMENT

A Vulnerability Assessment gives quantitative estimates of the people and property in your community that are vulnerable to each hazard. The simplest technique to assess vulnerabilities is to compare the community profile map with hazard maps for the same area, to find areas where hazards overlap with the locations of people, structures and infrastructure. Areas where hazards overlap with development should be examined more closely to estimate what kinds of damages might occur during an emergency event. The goal should be to produce specific information that **measures** the threats from each hazard (depth of flooding, amount of service interruption, amount of traffic delays, number of casualties, amounts of physical damage, economic costs, number of families displaced, and so on). As shown in the last section (on Risk Assessment), information such as the number of persons at risk, the number of structures vulnerable to damage, or estimates of economic losses, are all *quantifiable* concepts. There is no need at this point to reach perfect accuracy with these measurements. In the hazard analysis, they will mainly be used to compare hazards with each other, to prioritize them and determine which ones your community is most vulnerable to. An advanced hazard analysis can also allow a cost-benefit analysis to be performed, which will mathematically justify the expense of mitigation projects, land use restrictions, and other important policy decisions. A Risk Assessment Table, as shown previously, is often merely a convenience to summarize the results of a detailed analysis. In a detailed analysis, hazard-specific disaster scenarios can be considered, in which "worst-case scenarios" are considered. Such scenarios are essentially a brainstorming activity to aid in determining what additional impacts each hazard might cause. The types of impacts that may be considered include:

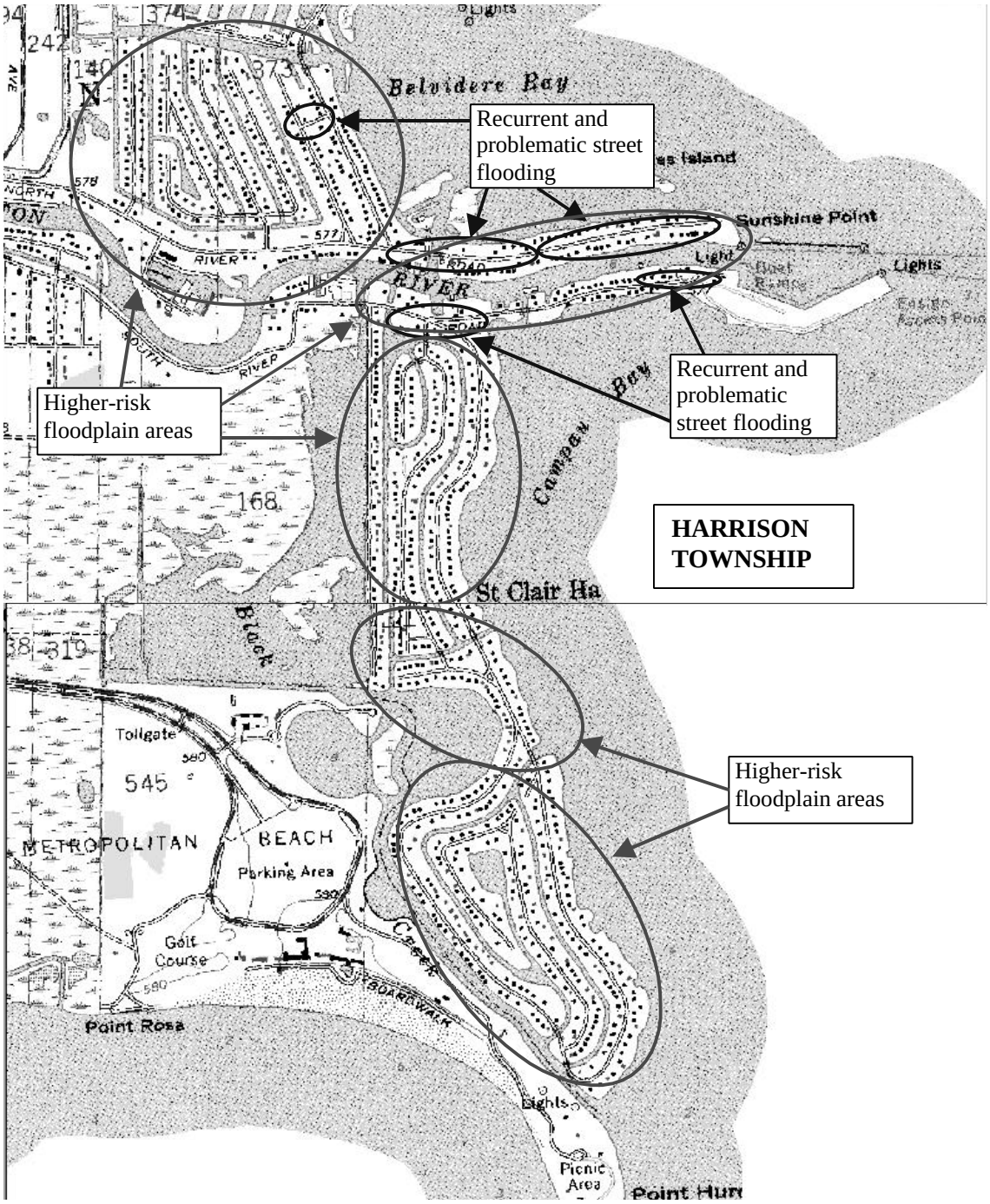
- Impacts on specific sectors of the community (see previous page regarding multi-jurisdictional plans)
- Damage to structures – the number and type of structures, estimated costs of damage (including contents)
- Life safety consequences and issues (potential deaths, injuries, search and rescue situations, etc.)
- Critical loss of function consequences and issues (lifelines, police/fire/EMS, special needs groups, etc.)
- Public health consequences and issues such as contaminated water, disease, vector control (insects and animals that can spread disease to humans), etc.
- Economic consequences and issues (loss of business activity, unemployment, response and recovery costs)
- Recovery issues and concerns (re-building public and private facilities, housing needs, project funding, hazard mitigation, etc.)

After applying the various hazard-specific disaster scenarios, the community will have a good idea, in terms of potential numbers, of what it could reasonably expect to encounter in similar situations. It may not be necessary to develop and apply scenarios for EVERY known hazard in the community. At this stage of the analysis, efforts may be focused toward the most important hazards. Each community will have to make that determination based on its needs, priorities and resources. **Vulnerabilities will later be addressed through specific mitigation strategies.** (See steps 2 through 5.) **Your plan should contain enough detail to help FEMA estimate whether a particular mitigation project will pass a cost-benefit analysis** (see Appendix B).

Text, tables and maps can be used to depict the consequences, issues and considerations raised in the disaster scenarios. This could then serve as a basis for determining community priorities for mitigation activities, emergency planning, and resource allocation. The results should also be used by the community's land use and public facility planners to avoid allowing future developments in hazardous areas.

A Flood Vulnerability map appears on the next page as an example of identifying areas where a hazard overlaps with urban developments. Notice that this vulnerability map allows more detail because it focuses only on one small portion of a community, in which a floodplain overlaps with developed areas. The background layer of the map (identifying structures, water bodies, and other community features) was adapted from existing USGS information. (Such information can be obtained at http://www.topozone.com/, among other sources.) Areas on this base map were then highlighted and marked with descriptive text boxes, using ordinary office software, to produce a customized flood vulnerability map suitable for use in a hazard mitigation plan.

A second map (produced in the same way) follows the first one, to give some more ideas of the type of analysis that is desirable when analyzing spatial hazards such as urban, riverine, and shoreline flooding. As noted before, these maps were originally in color to help readers sort through the provided information.

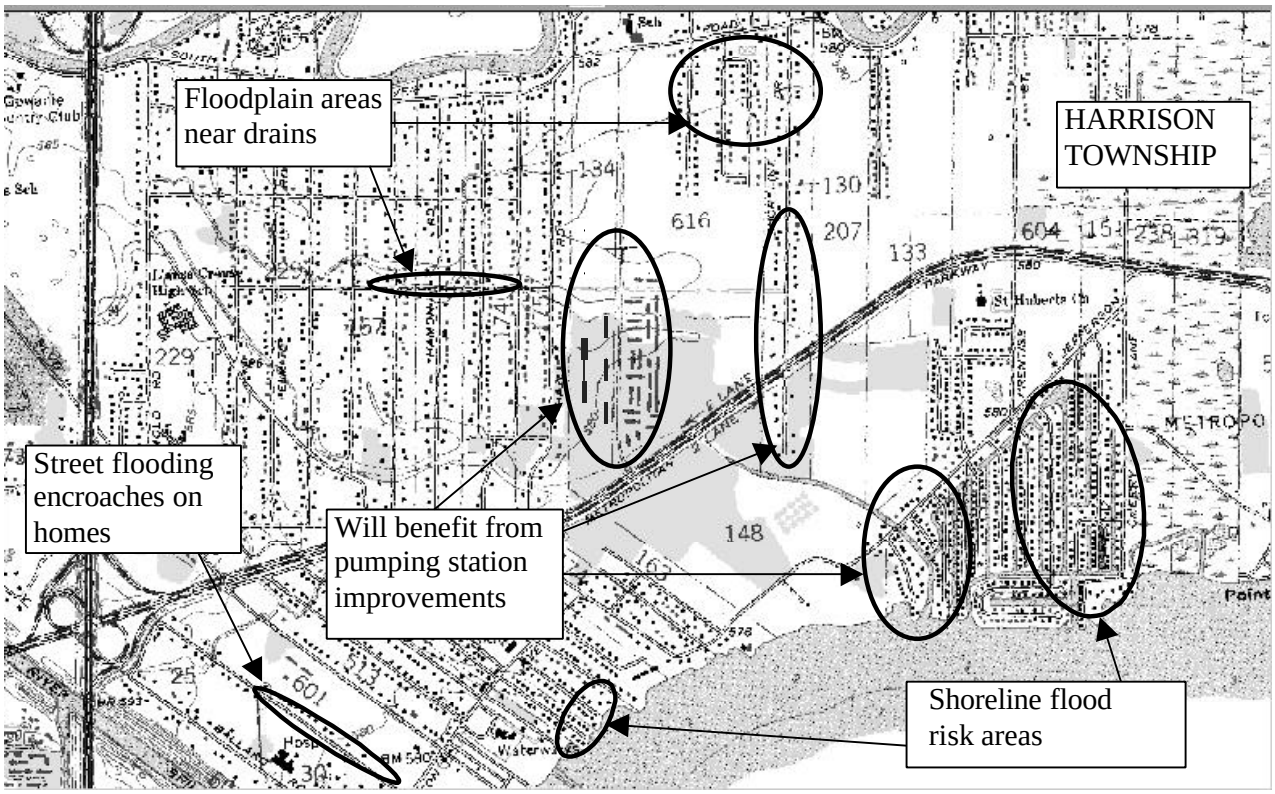


EXAMPLE OF FLOOD HAZARD SECTOR MAP
FOR A VULNERABILITY ASSESSMENT

Appropriate text description would accompany these sorts of maps in an actual mitigation plan. Areas of identified vulnerabilities would also be included in the community's mitigation goals as they proceed from their hazard analysis into developing an actual hazard mitigation plan. (This will be covered in the next section: "Step 2: Define Goals and Objectives.")

The areas identified on vulnerability maps can be compared with tax assessment or decennial census data to estimate the nature and number of persons and property at-risk. For commercial businesses, direct inquiries,

surveys, or government information (from the economic census, County Business Patterns, the Regional Economic Information System) can be helpful for determining loss of jobs, productivity, and so on.



Impacts on area infrastructure and services should also be noted where possible. The locations of specific mitigation projects (such as the "pumping station improvements" in the map above) can also be identified, once these projects have been determined to be desirable for the community.

What is the Difference between Risk and Vulnerability?

This workbook has tended to blend the Risk and Vulnerability Assessments together, because in hazard mitigation planning, there is not firm agreement about exactly where the line is drawn between these concepts when creating a hazard analysis. One tradition holds that risk is a more general concept, and vulnerability is a more specific, quantitative assessment of the anticipated effects of hazards. In a similar sense, one can see "risk" as describing specific hazards such as severe weather (a particular chance of a certain amount of snowfall, for example), while vulnerability then examines the sort of impact that such hazards are actually likely to have on the community. A house may exist in a floodplain (according to a risk assessment) but if the house has been elevated above expected flood levels, it may not actually be vulnerable to such a hazard.

Any of these approaches can be fine, as long as the ultimate goals of a hazard analysis are achieved. Hazards should be assessed and vulnerable areas of the community should be identified. Priorities should be set, because any good analysis will reveal that some risks are more threatening than others. The best available information and planning expertise should be utilized to sort through the many potential hazard impacts that exist. The nature of hazards, information, and planning resources will vary in each community

As with Risk Assessment information, a summary table can be produced that summarizes different types of identified hazard vulnerabilities in your community. Some of these may not be easily quantified, but are still important to consider. A table appears on the next page to illustrate this.

(name of community) Vulnerability Determination: (year) (EXAMPLE)

HAZARD	Sector Issues	Life Safety Issues	Loss of Function Issues
1. **(FOR EXAMPLE): Riverine Flooding**	a. 80% of Pine Twp. residents are elderly b. Only bridge in Village of Stormy is floodprone c. Seafarer Twp. has summer population increase of 35,000 people d. City of Rolling Hills has many businesses in Pine River floodplain	a. Flash flood on Pine River could result in many deaths and injuries b. Large number of elderly residents in county makes warning difficult c. County has limited water rescue capability d. Propane tanks in floodplain not anchored	a. No backup generator in police station in City of Rolling Hills b. Rolling Hills fire station located in floodplain c. Several sewage lift stations in Pine Twp. are prone to flood damage d. Gas main under Pine River bridge vulnerable
	Public Health Issues	**Economic Issues**	**Recovery Issues**
	a. Flooding contaminates private wells in Pine Twp. b. Flooded buildings become contaminated c. Mosquito, rodent and snake populations swell after flooding d. Flood-soaked debris gets piled up for long periods of time	a. Businesses in Pine River floodplain must close for up to two weeks b. Post-flood recovery and cleanup costs are very high c. Public facilities in Rolling Hills incur repetitive damage	a. Damaged public facilities cannot be used for up to two weeks after flood b. Flooded residents must be temporarily housed for up to two weeks c. Potential for business closures due to repetitive flood damage

Another Technique for Prioritizing Hazards

A useful task in the Vulnerability Assessment is to rank hazards according to how vulnerable your community is to each of them. The Risk Assessment Summary Table shown previously had a column in which this ranking could be inserted. Such ranking will help to prioritize mitigation efforts according to the severity of a hazard's risks which they address. The technique of assigning appropriate monetary values to the various types of harm that could occur has already been suggested as a vital part of an advanced hazard analysis document. As part of a standard hazard analysis (or when certain types of vulnerability are not readily quantifiable in dollar terms), a somewhat simpler technique may be used to determine priorities and provide a framework for awareness, analysis, debate, and consensus-building in your community. The essential concept of this technique is to break each hazard into different components of risk and to weigh hazards against each other using a "weighted average." Instead of a normal average which would treat each aspect of a hazard as equal, a weighted average specifies that although all effects of a hazard may be significant, *some* hazard impacts are much more important than others, and therefore *weigh* more heavily in an overall assessment of the community's risks and priorities. The next few pages give a step-by-step description of how this technique can be used to determine your community's priorities, and to guide public understanding, input, debate, and agreement on the topics.

(NOTE: This information was presented as an optional technique under Appendix B in the previous edition of this workbook. It is now recommended that this, some similar technique such as the economic quantification described in the Risk Assessment section of this workbook, or a similarly detailed method shall be used to explain how risks to your community were assessed and prioritized in your hazard analysis. The technique given over the next few pages is really not that difficult so long as the instructions are understood and followed step-by-step. If any questions arise, or if you wish to request more specific instruction, please contact the Mike Sobocinski, Local Hazard Mitigation Planner with MSP-EMD, at 517/336-2053 or sobocinm@michigan.gov.)

This "weighted average" technique of assessing and prioritizing your hazards should be used if you have trouble using another technique to quantify and compare the different hazards facing your community. It will also be extremely useful to describe to others (at meetings, or those reading your hazard analysis and hazard mitigation plan) how you assessed that your community is more vulnerable to some hazards than to others. You will especially want to use a technique like the Hazard Assessment Ratings described here if you do not have the information or resources to assess your risks in economic terms using the cost-benefit analysis or some comparable technique as described in the Risk Assessment Section.

This section will describe each step of the process. Even if you are unfamiliar with the reasoning behind the use of a "weighted average," in the end the results should make sense to you. You will probably want to discuss your choices and use of this technique with other local officials to be certain that your conclusions reflect the goals and attitudes of your community. If they do, it will be much easier to gain community support and official approval for your emergency management goals and mitigation projects as a result of the mitigation plan that will emerge from this process.

1. Choose evaluation criteria – A hazard can be seen in terms of the many potential impacts it can have on your community. Let us begin the analysis by considering these aspects of hazards. A list of suggested hazard aspects appears in the left column of the table below. Look over this list and determine what aspects of a hazard are of most concern to those in your community. (If you need to, look over the list of natural, technological, and social/societal hazards on the next page. These are the types of hazards you will be prioritizing based on this list of hazard aspects.) Are rare but destructive events of greater concern than persistently annoying hazards? If so, then you will want to pick hazard aspects that reflect that judgement. Go through the list (you may add new items to it if you like) and determine (in consultation with others whenever possible) which items you and those in your community feel would be useful in evaluating each hazard. Check the column that you feel best describes how important each aspect of a hazard is. If you decide not to consider a particular aspect, mark the right column called "Not Worth Considering." Those aspects will not be considered in the assessment that will follow. Marking any other column means that an aspect will at least be given a little bit of consideration in assessing which hazards are more important. You may select these columns for only a few aspects, or may select the entire list as at least worth considering, and even add a few more of your own items to the end of the list (such as recovery issues or public health concerns, as listed in the Vulnerability Determination Table). The important point is to select at least some items as a basis for assessing hazard vulnerabilities in your area.

Hazard Aspect	Always Very Important	Usually Important	Sometimes Important	Rarely of Importance	Not Worth Considering
Likelihood of Occurrence					
Capacity to cause physical damages					
Size of Affected Area					
Speed of Onset (amount of warning time)					
Percent of population affected					
Potential for causing casualties					
Potential for negative economic effects					
Duration of threat from hazard					
Seasonal risk pattern					
Environmental impact					
Predictability of hazard					
Ability of hazard impacts to be mitigated					
Availability of warning systems					
Public awareness of hazard					
Corollary effects (ability to cause other hazards)					
(Other considerations may be added to this list)					

2. Assign "weights" to express the importance of each hazard aspect – If you have decided that some hazard aspects are not worth considering, remove them from the list. All remaining hazard aspects are of at least a little importance to you, and you now need to convert your initial selections into a clearer means of weighing the importance of some hazard aspects against others. You may have picked the entire list as being of some importance, or you may have picked only a few aspects as worth considering. (The fewer you pick, the easier the analysis will be, but at minimum you should probably include the likelihood of occurrence [risk], and some measures of harm that could be caused [such as casualties and physical destructiveness].) Your task now is to

convert your choices into a set of numbers that all add up to 100 (or, as percentages that all add up to the number one).

Envision in your mind the total effect of things you consider harmful to your community. (These things should be covered in some way on the list of hazard aspects you have selected.) Now picture harm to your community as being made up of the sum of all these different aspects that you have selected as important: negative economic effects, property damage, loss of life, and so on. Now picture that since harm is composed of these things, each of them makes up a portion of the whole, just as slices of pie make up the entire pie. If you have picked some hazard aspects as being more important than others, the ones that were considered most important should therefore make up larger slices of the overall pie. You might feel that casualties were the most important hazard aspect, followed by the likelihood of occurrence, but that environmental impacts and political awareness of the hazard must not be completely ignored. If we picture these hazard aspects as slices of a pie, you should estimate how big a slice is adequate to give to each one of these concerns about hazards. If the importance of casualties is greater than current political awareness of a given hazard, you should assign that a larger slice of pie. The size of each slice will be measured as a percentage of the whole. Take 100 percentage points and divide them up between all the hazard aspects you have selected above, so that more important aspects are given more points than less important ones. It doesn't need to be perfect at first; you can go back and change the numbers later on after you've thought about it more and discussed it with others in your community.

The result of your "pie-slicing" will be numbers attached to each selected hazard aspect, which will add up to a total of 100 percentage points (which equals a whole). If you have picked four aspects and they are all equally important, each one accounts for 25% of the whole. Perhaps they are not equal; maybe the casualties slice of the pie is 50 percent of the whole, being considered twice as important as another that then accounts for 25 percent. The other two aspects will have 25 percent together (possibly 10% for one and 15% for the other) so that the total of all hazard aspects will be 100%. The degree of importance you gave each aspect in the table above can help you estimate what percentage (from the total of 100) to assign it. Those considered "always very important" should be assigned a greater percentage than those considered "Usually Important" or "Sometimes Important," and so on. After you have compared these hazard aspects for a while, make sure the add up to 100% and roughly express how casualties compare with economic impacts, and so on, in your view of what is most important or potentially harmful to your community. You will then be ready to use these "weights" to make a balanced comparison of your community's hazards, based on the aspects of hazards that were considered important.



3. Begin to make a Hazard Assessment Rating Table – Make a table with a list of all significant hazards going down the left-most column. In the top row, label the other columns of the table with the aspects for hazard evaluation that you have just selected and assigned percentages to. Do not yet place numbers into any of the cells within this table. Merely begin by listing the hazards along the left, and the evaluation criteria along the top. An example appears on the next page.



Hazard Assessment Rating Table

EXAMPLE: FOR INSTRUCTIONAL PURPOSES ONLY

Hazard	Likelihood of Occurrence (30%)	Percent of population affected (20%)	Potential for causing casualties (20%)	Potential for negative economic effects (15%)	Corollary effects (10%)	Public awareness of hazard (5%)
Civil disturbances						
Drought						
Earthquakes						
Extreme temperature						
Scrap tire fires						
Structural fires						
Wildfires						
Dam failures						
Riverine flooding						
Shoreline flooding						
Fixed site hazmat incident						
Hazmat transportation incident						
Infrastructure failures						
Nuclear attack						
Nuclear power plant accidents						
Oil & gas well accidents						
Pipeline accidents						
Public health emergencies						
Terrorism/sabotage/WMD						
Subsidence						
Hail						
Lightning						
Severe winds						
Tornadoes						
Transportation accidents						
Winter weather hazards						

EXAMPLE: FOR INSTRUCTIONAL PURPOSES ONLY

4. Select rating scale for each hazard evaluation aspect – Next, each cell in the table will be filled in with a number from a specific rating scale, such as from 0 to 10. Using this scale, a rating of 0 would represent a condition that poses no threat to the community, while a rating of 10 would represent a condition of serious and unmitigated threat. Numbers in between 0 and 10 will represent conditions between these two extremes. Each number in a cell will represent the seriousness of a hazard in terms of one of the hazard evaluation aspects you have chosen. (NOTE: this new scale from 0 to 10 is not related to the 100 percentage points that you previously assigned among these criteria – those percentages are use to show how much weight each hazard aspect is being given; each rating from 0 to 10 will be adjusted by the percentage weights in a later step of this process.)

Before you fill in any specific numbers, you should give some thought to what the numbers between 0 and 10 will mean. This will help your rating of the hazards to be consistent and accurate. To illustrate, let's consider the criterion of "Likelihood of Occurrence." This is a measure that you may have chosen (and may have already estimated in a Risk Assessment Summary Table). A rating of zero on this measure that would represent the least threatening condition, which would mean that there is no chance of occurrence in your community. A rating of 10 would represent a continually occurring hazard. In between these extremes, you might place numbers such as "3: usually occurs once every 10 years", "5: occurs every year", "8: occurs every week", or any other estimates that you consider appropriate for the hazards affecting your community. Think about the range of likelihoods for all the hazards in your area and use that to determine what a "3," "5," "7," and other numbers will actually stand for. Once you have written out your rating scale, you should be able to use it to rate all your communities hazards from 0 to 10 on this aspect of threat (in this example, "likelihood of occurrence" is the aspect being considered).

Proceed on to your next chosen criterion and again come up with some ideas about a rating scale from 0 to10. For example, "size of affected area" would have conditions ranging from "0: none of my community would be affected" to "10: my entire community would be affected." Go through your entire list of selected hazard aspects and define what numbers from 0 to 10 can be used to describe the range of conditions, from the least

threatening to the most, for that particular aspect of any hazard. Make sure that 0 is always the least threatening condition. For example, on "Ability of hazard impacts to be mitigated," the least threatening condition would be a hazard that is easy to completely eliminate, while the most threatening condition is one that is impossible to mitigate. (Strategies to improve preparedness, response, or recovery would be appropriate for such hazards, if they truly can't be mitigated.)

5. Rate each hazard from 0 to 10 on all the aspects you have chosen – Now you should begin to insert values into each cell of the table you have made. It is recommended that this be done in pencil, or that extra space be left to change these values later in the analysis. A computer spreadsheet can also be used, which allows changes to be made very easily in the table.

For each hazard listed in the left column, go across its row to the right and fill in a rating from 0 to 10. The numbers represent your assessment of each aspect of the hazard, using the rating scales you have just created. Below is an example of what a table might look like after this step has been completed. After you have filled in all empty cells of your table with a number from 0 to 10 like this, you will then be ready to calculate the overall risk from each hazard.

Hazard Assessment Rating Table

EXAMPLE: FOR INSTRUCTIONAL PURPOSES ONLY

ALL NUMBERS IN TABLE SHOW HOW EACH HAZARD RATES ON A SCALE FROM 0 TO 10. Hazard:	Likelihood of Occurrence (30%)	Percent of population affected (20%)	Potential for causing casualties (20%)	Potential for negative economic effects (15%)	Corollary effects (10%)	Public awareness of hazard (5%)
Civil disturbances	2	2	3	6	3	1
Drought	3	7	1	5	3	2
Earthquakes	1	5	1	2	2	1
Extreme temperature	7	9	3	3	4	4
Scrap tire fires	1	1	1	4	2	1
Structural fires	9	1	4	4	2	5
Wildfires	5	5	5	5	3	9
Dam failures	2	2	8	7	5	3
Riverine flooding	7	2	4	4	5	8
Shoreline flooding	4	1	2	4	2	7
Fixed site hazmat incident	3	1	6	4	2	4
Hazmat transportation incident	6	3	6	4	3	2
Infrastructure failures	7	9	3	5	5	8
Nuclear attack	1	10	7	10	9	3
Nuclear power plant accidents	1	1	1	2	2	2
Oil & gas well accidents	2	1	3	3	3	1
Pipeline accidents	2	3	5	6	5	2
Public health emergencies	3	4	4	5	3	2
Terrorism/sabotage/WMD	2	4	7	7	8	1
Subsidence	1	1	1	1	2	1
Hail	5	4	1	2	3	2
Lightning	5	2	2	4	4	2
Severe winds	6	9	3	4	6	4
Tornadoes	3	6	6	8	7	8
Transportation accidents	6	2	5	6	4	2
Winter weather hazards	8	9	4	5	7	4

SCALE: from 0 (poses the least threat) to 10 (poses the greatest threat)
EXAMPLE: FOR INSTRUCTIONAL PURPOSES ONLY

6. Calculate the overall hazard assessment ratings – The math is quite simple, since it only uses addition and multiplication. A new column should be added on the right side of the Hazard Assessment Rating Table. The new column will contain the overall rating for each hazard, which will be calculated now. Take the percentage weight for each column and multiply it by the number in each cell that you have given a rating on the 0 to 10 scale. Make sure that the same percentage is used for each entire (vertical) column in the table. In the example table above, each cell in the column marked "Likelihood of Occurrence (30%)" will be multiplied by **.**30—the numerical equivalent of the percentage that was assigned to that aspect of the hazards. The next column marked "Percent of Population Affected (20%) will have each number multiplied by **.**20. After all the cells in the table

have been multiplied by the appropriate percentages, the results from the cells in each row of the table should be added together from left to right. This will result in a single number from 0 to 10 for each hazard, called the hazard assessment rating, and can be entered into the new column that was added onto the right side of the table, as seen in the example table below.

Hazard Assessment Rating Table

EXAMPLE: FOR INSTRUCTIONAL PURPOSES ONLY

Hazard	Likelihood of Occurrence 30%	Percent of population affected 20%	Potential for causing casualties 20%	Potential for negative economic effects 15%	Corollary effects 10%	Public aware-ness of hazard 5%	Total rating: sum of all columns (100%)
Civil disturbances	2 x 0.30 = **0.6**	2 x 0.20 = **0.4**	3 x 0.20 = **0.6**	6 x 0.15 = **0.9**	3 x 0.10 = **0.3**	1 x 0.05 = **0.05**	**2.85**
Drought	3 x 0.30 = **0.9**	7 x 0.20 = **1.4**	1 x 0.20 = **0.2**	5 x 0.15 = **0.75**	3 x 0.10 = **0.3**	2 x 0.05 = **0.1**	**3.65**
Earthquakes	1 x 0.30 = **0.3**	5 x 0.20 = **1.0**	1 x 0.20 = **0.2**	2 x 0.15 = **0.3**	2 x 0.10 = **0.2**	1 x 0.05 = **0.05**	**2.05**
Extreme temperatures	7 x 0.30 = **2.1**	9 x 0.20 = **1.8**	3 x 0.20 = **0.6**	3 x 0.15 = **0.45**	4 x 0.10 = **0.4**	4 x 0.05 = **0.2**	**5.55**
Scrap tire fires	1 x 0.30 = **0.3**	1 x 0.20 = **0.2**	1 x 0.20 = **0.2**	4 x 0.15 = **0.6**	2 x 0.10 = **0.2**	1 x 0.05 = **0.05**	**1.55**
Structural fires	9 x 0.30 = **2.7**	1 x 0.20 = **0.2**	4 x 0.20 = **0.8**	4 x 0.15 = **0.6**	2 x 0.10 = **0.2**	5 x 0.05 = **0.25**	**4.75**
Wildfires	5 x 0.30 = **1.5**	5 x 0.20 = **1.0**	5 x 0.20 = **1.0**	5 x 0.15 = **0.75**	3 x 0.10 = **0.3**	9 x 0.05 = **0.45**	**5.00**
Dam failures	2 x 0.30 = **0.6**	2 x 0.20 = **0.4**	8 x 0.20 = **1.6**	7 x 0.15 = **1.05**	5 x 0.10 = **0.5**	3 x 0.05 = **0.15**	**4.30**
Riverine flooding	7 x 0.30 = **2.1**	2 x 0.20 = **0.4**	4 x 0.20 = **0.8**	4 x 0.15 = **0.6**	5 x 0.10 = **0.5**	8 x 0.05 = **0.4**	**4.80**
Shoreline flooding	4 x 0.30 = **1.2**	1 x 0.20 = **0.2**	2 x 0.20 = **0.4**	4 x 0.15 = **0.6**	2 x 0.10 = **0.2**	7 x 0.05 = **0.35**	**2.95**
Fixed site hazmat incident	3 x 0.30 = **0.9**	1 x 0.20 = **0.2**	6 x 0.20 = **1.2**	4 x 0.15 = **0.6**	2 x 0.10 = **0.2**	4 x 0.05 = **0.2**	**3.30**
Hazmat transportation incident	6 x 0.30 = **1.8**	3 x 0.20 = **0.6**	6 x 0.20 = **1.2**	4 x 0.15 = **0.6**	3 x 0.10 = **0.3**	2 x 0.05 = **0.1**	**4.60**
Infrastructure failures	7 x 0.30 = **2.1**	9 x 0.20 = **1.8**	3 x 0.20 = **0.6**	5 x 0.15 = **0.75**	5 x 0.10 = **0.5**	8 x 0.05 = **0.4**	**6.15**
Nuclear attack	1 x 0.30 = **0.3**	10 x 0.20 = **2.0**	7 x 0.20 = **1.4**	10 x 0.15 = **1.5**	9 x 0.10 = **0.9**	3 x 0.05 = **0.15**	**6.25**
Nuclear power plant accidents	1 x 0.30 = **0.3**	1 x 0.20 = **0.2**	1 x 0.20 = **0.2**	2 x 0.15 = **0.3**	2 x 0.10 = **0.2**	2 x 0.05 = **0.1**	**1.30**
Oil & gas well accidents	2 x 0.30 = **0.6**	1 x 0.20 = **0.2**	3 x 0.20 = **0.6**	3 x 0.15 = **0.45**	3 x 0.10 = **0.3**	1 x 0.05 = **0.05**	**2.20**
Pipeline accidents	2 x 0.30 = **0.6**	3 x 0.20 = **0.6**	5 x 0.20 = **1.0**	6 x 0.15 = **0.9**	5 x 0.10 = **0.5**	2 x 0.05 = **0.1**	**3.70**
Public health emergencies	3 x 0.30 = **0.9**	4 x 0.20 = **0.8**	4 x 0.20 = **0.8**	5 x 0.15 = **0.75**	3 x 0.10 = **0.3**	2 x 0.05 = **0.1**	**3.65**
Terrorism/sabotage/WMD	2 x 0.30 = **0.6**	4 x 0.20 = **0.8**	7 x 0.20 = **1.4**	7 x 0.15 = **1.05**	8 x 0.10 = **0.8**	1 x 0.05 = **0.1**	**4.75**
Subsidence	1 x 0.30 = **0.3**	1 x 0.20 = **0.2**	1 x 0.20 = **0.2**	1 x 0.15 = **0.15**	2 x 0.10 = **0.2**	1 x 0.05 = **0.1**	**1.15**
Hail	5 x 0.30 = **1.5**	4 x 0.20 = **0.8**	1 x 0.20 = **0.2**	2 x 0.15 = **0.3**	3 x 0.10 = **0.3**	2 x 0.05 = **0.1**	**3.20**
Lightning	5 x 0.30 = **1.5**	2 x 0.20 = **0.4**	2 x 0.20 = **0.4**	4 x 0.15 = **0.6**	4 x 0.10 = **0.4**	2 x 0.05 = **0.1**	**3.40**
Severe winds	6 x 0.30 = **1.8**	9 x 0.20 = **1.8**	3 x 0.20 = **0.6**	4 x 0.15 = **0.6**	6 x 0.10 = **0.6**	4 x 0.05 = **0.2**	**5.60**
Tornadoes	3 x 0.30 = **0.9**	6 x 0.20 = **1.2**	6 x 0.20 = **1.2**	8 x 0.15 = **1.2**	7 x 0.10 = **0.7**	8 x 0.05 = **0.4**	**5.60**
Transportation accidents	6 x 0.30 = **1.8**	2 x 0.20 = **0.4**	5 x 0.20 = **1.0**	6 x 0.15 = **0.9**	4 x 0.10 = **0.4**	2 x 0.05 = **0.1**	**4.60**
Winter weather hazards	8 x 0.30 = **2.4**	9 x 0.20 = **1.8**	4 x 0.20 = **0.8**	5 x 0.15 = **0.75**	7 x 0.10 = **0.7**	4 x 0.05 = **0.2**	**6.65**

EXAMPLE: FOR INSTRUCTIONAL PURPOSES ONLY

This work can be quite simple for those who use spreadsheet software, but such software is not necessary so long as the basic math has been done carefully, and double-checked for correctness. The result of these estimates and calculations is that each hazard is given a specific rating which can be used to establish (and

explain) mitigation priorities in your community. In the example table on the next page, each hazard has ratings assigned in the right-most column, and if these are placed in descending order, the example community's top hazards have been calculated as follows:

1. Winter weather hazards (rated 6.65)
2. Nuclear attack (6.25)
3. Infrastructure failures (6.15)
4 & 5. Tornadoes and severe winds (5.60)
6. Extreme temperatures (5.55)
7. Wildfires (5.00)
8. Riverine flooding (4.80)
9 & 10. Structural fires and terrorism/sabotage/WMD
11 & 12. Transportation accidents/transportation hazardous material incidents
13. Dam failures

For this hypothetical community, other significant hazards are pipeline accidents, drought, public health emergencies, lightning, fixed site hazardous material incidents, hail, shoreline flooding, and civil disturbances. The hypothetical community's least significant hazards were calculated to be oil & gas well accidents, earthquakes, scrap tire fires, nuclear accidents, and subsidence. For other communities, these calculations would probably be much different. **In multi-jurisdictional plans, it may be necessary to identify different priorities for each of the communities that are covered by the plan.**

The results of this detailed technique are hazard rankings that can be entered into the Risk Assessment Table and used to establish which hazards are higher-priority. Proper use of this technique also provides a way to build consensus about these priorities, and to explain (or defend) decisions that have been made from these priorities.

How much analysis is needed?

This workbook tends to avoid giving fixed requirements about exactly how much analysis is required, because your mitigation plan must assess and then address all hazards that are significant for your community rather than to follow a specific blueprint or preconceived formula. Avoiding a "boiler plate" approach keeps community mitigation plans flexible, so they can be easily customized to meet an area's needs with the resources that are available to it. One community may already have plenty of data and planning resources available, while another community may feel completely strapped and overwhelmed. A good general principle is to use "best available data" in a way that is efficient and most pertinent to your community's resources and challenges. (Each community's hazards, priorities, and resources are different, so their plans will be also.) On the negative side, those who are new to mitigation planning may find it easier to be given specific lists of what to do, to swiftly complete a quality hazard mitigation plan simply by completing each step on a checklist. Although this document remains flexible by providing few specific checklists, you should study Appendix C if your plan is intended to fulfill grant requirements for federal hazard mitigation programs and meet the planning requirements of the Disaster Mitigation Act of 2000. If you seek "best practices" for analyzing high-priority hazards, please refer to the information in Appendix B.

The Vulnerability Assessment, and indeed the entire Hazard Analysis, can be considered complete when (1) specific areas of the community have been identified that are vulnerable to harm from hazards, (2) these areas of vulnerability have been prioritized with estimates of which threats are most important to address, and (3) defensible explanations have been given as to *why* these areas are believed to be vulnerable to hazards, or *how* such vulnerabilities were determined. You will then be ready to plan how to mitigate such vulnerabilities.

Having a presentable and complete document explaining your hazard analysis will allow the information you've researched to be examined and used by many important people in your community, whether planners, officials, or others in emergency management. Feedback and suggestions from these people can be very useful and important for making the hazard analysis as accurate and useful as possible.

This section has given only a few examples of the techniques that can be used to assess risks, identify vulnerabilities, and establish priorities. For more information about specific types of information and techniques

that can be used to analyze different sorts of hazards in your community, please refer to Appendix B in this workbook. It will describe the ways that you can think about and measure the risk from each type of hazard that may be a priority in your community.

If your community is developing a hazard mitigation plan so as to meet the requirements of the Disaster Mitigation Act of 2000 (and the federal regulations that are based on it), please refer to Appendix C in this workbook. Appendix C will also be a necessary reference if you are receiving federal grant money from the Flood Mitigation Assistance Program (FMAP), the Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Program (PDMP) or Project Impact (PI). Although it has been stated that FEMA intends to standardize the planning requirements for all these programs into a single set of standards under the Disaster Mitigation Act of 2000 (DMA2000), it may be important for you to distinguish between the new DMA2000 requirements and the standards that had previously been used for hazard mitigation planning under other programs. Appendix C should be extremely helpful on these matters.

Because hazard mitigation planning is new to many communities and planning offices, most communities in Michigan will be dealing with it for the first time during the years 2003 and 2004, when FEMA is funding these activities to assist in meeting their new requirement that communities will be required to have an locally adopted and FEMA-approved local hazard mitigation plan in order to be eligible to receive federal hazard mitigation project funds under the grant programs named above. Most communities will therefore be creating a document that specifically addresses hazard mitigation at the local level—this document would be called a "stand-alone" plan if it only addresses hazard mitigation. The alternative to this is to integrate hazard analysis and mitigation activities into community comprehensive plans. Comprehensive plans are documents that guide land use and development in a community for a number of years into the future (usually between 5 and 20 years). Comprehensive plans may also be called master plans, development plans, or land use plans. They generally contain a broad and integrated perspective on your community's needs and goals, with more detailed subsections that address topics such as zoning, economic development, transportation, recreation, environment and open space, energy, infrastructure, and capital facilities. There may be related plans that have been produced for your community, such as for solid waste management or watershed management. If your community is in the process of updating one or more of these plans during the next year or two, it may be possible to integrate hazard mitigation into such planning activities. Appendix D in this workbook gives information on how such integration can be achieved. Because many hazards can be created or worsened by long-term decisions that did not take such issues into account, it is important that such a problem be corrected by including hazard mitigation in future planning considerations. A long-term goal of the Michigan State Police Emergency Management Division, and the governor-appointed Michigan Hazard Mitigation Coordinating Council (MHMCC), is that coordination and partnerships be formed between planning and emergency management activities and professions throughout the state.

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Summary

At this stage, your community should have a good idea of what the its problems are, which will provide a solid foundation for setting hazard mitigation goals and identifying more specific hazard mitigation activities as part of its planning process. In the next step of the planning process, you will develop broad goals and more specific objectives as you use your hazard analysis to determine what your community will ***do*** to lessen its potential to be harmed by natural, technological, and social/societal hazards.